



United States General Accounting Office

Report to the Honorable
Elizabeth Furse, House of
Representatives

February 1997

MILITARY AIRLIFT

Options Exist for Meeting Requirements While Acquiring Fewer C-17s



EXAMINATION STATEMENTS

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United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

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February 19, 1997

The Honorable Elizabeth Furse
House of Representatives

Dear Mrs. Furse:

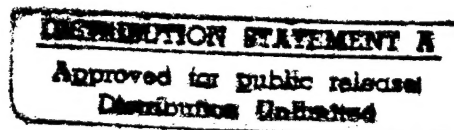
This report responds to your request that we review the basis for the November 1995 recommendation by the Defense Acquisition Board that a fleet of 120 C-17s be acquired to meet airlift needs. Specifically, the report addresses the basis for the November recommendation, explores whether less costly options exist to meet airlift needs, and identifies an issue concerning the use of the C-17 to support a strategic brigade airdrop.

As you requested, we plan no further distribution of this report until 5 days after its issue date. At that time, we will send copies to the Chairmen and Ranking Minority Members, Senate Committee on Armed Services; House Committee on National Security; Senate Subcommittee on Defense, Committee on Appropriations; and House Subcommittee on National Security, Committee on Appropriations. We will also send copies to the Secretaries of Defense and the Air Force; the Director, Office of Management and Budget; and other appropriate parties. We will make copies available to others on request.

Please call me at (202) 512-4841 if you or your staff have any questions about this report. Major contributors to this report are listed in appendix III.

Sincerely yours,

Louis J. Rodriguez
Director, Defense Acquisitions Issues



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Executive Summary

Purpose

The Congress had expressed concern about whether the C-17 was the most cost-effective airlifter for the Air Force to procure, given the aircraft's history of cost, schedule, and performance problems. The Congress had required the Department of Defense (DOD) to establish a Non-Developmental Airlift Aircraft program to acquire a commercially available transport aircraft as a substitute for or complement to a fleet of C-17s. As a result of a November 1995 decision by the Defense Acquisition Board, DOD plans to buy 120 C-17s and no commercially available transport aircraft. DOD concluded that the advantages of buying the C-17 outweighed any potential cost savings from acquiring a mixed fleet. Given the \$43 billion price for the C-17 program, Congresswoman Elizabeth Furse asked GAO to explore whether less costly alternatives to procuring 120 aircraft exist while still satisfying the nation's airlift requirements. This report responds to that request.

Background

The C-17 aircraft, an air refuelable, four-engine jet transport, is being manufactured by the McDonnell Douglas Corporation. The C-17 is to replace the C-141 transport in the current fleet and complement the larger but less maneuverable C-5 aircraft. When the program began in 1982, the Air Force planned to acquire 210 C-17s to augment its strategic airlift fleet. In 1990, as part of DOD's Major Aircraft Review, the Secretary of Defense reduced the program to 120 aircraft. In December 1993, due to ongoing concerns with the C-17's growing cost and continuing technical problems, the Secretary of Defense announced that the program would be stopped at 40 aircraft unless McDonnell Douglas could demonstrate that program cost, schedule, and performance improvements warranted completing the 120-aircraft program. Moreover, in March 1994, at congressional direction, DOD initiated a program to acquire a transport aircraft using commercial practices as a possible alternative or supplement to the C-17.

The Under Secretary of Defense for Acquisition and Technology convened a Defense Acquisition Board in October/November 1995 to determine (1) whether the C-17 aircraft program should continue past 40 aircraft and (2) how many additional C-17s and commercial transport aircraft should be procured. The Board decided to procure 120 C-17s and no commercial transports. The decision was based on several studies and analyses, including the results of the Joint Chiefs of Staff's 1995 Mobility Requirements Study Bottom-Up Review Update (MRS BURU), the Air Mobility Command's Strategic Airlift Force Mix Analysis, DOD's Tactical Utility Analysis, and C-17 cost and performance information presented by the Air Force.

Results in Brief

An option not considered by the Defense Acquisition Board, which may satisfy strategic airlift requirements, would be to acquire 100 C-17s and no commercial transport aircraft. This option would save the government over \$7 billion in life-cycle costs (fiscal year 1996 dollars). The savings would consist of over \$4 billion in acquisition costs and over \$3 billion in operating and support costs. Airlift needs could be met with this reduced number of C-17s if DOD implemented other individual measures, such as increasing prepositioning of Army combat support and combat service support materiel that would otherwise be delivered by air, using training aircraft (assumed to be unavailable in the MRS BURU to support major regional contingencies, increasing the use of Civil Reserve Air Fleet aircraft, increasing slightly the time frame for delivery, or by adopting some combination of these measures. Costs for implementing the measures would not be significant compared with the potential savings and have been accommodated in our estimate of the potential savings. A fleet with 100 C-17s would also be sufficient to support missions that require the unique military capabilities of the C-17, such as landing on a short runway.

The only mission that would require more than 100 C-17s in conjunction with the current fleet is an extended range brigade airdrop mission to a small, austere airfield directly from the continental United States. Until fiscal year 2004, when at least 114 C-17s will be available, the Air Force will not be able to support an extended range brigade airdrop to a small, austere airfield as called for in the Army's concept of operations. In the interim, the Air Force and the Army are considering other alternatives to perform the extended range brigade airdrop mission now required in DOD's Defense Planning Guidance. GAO believes alternatives could be used, with a fleet with 100 C-17s and modified C-5s, to support an extended range airdrop to either a small, austere or larger airfield either indefinitely or until the Air Force begins replacing the C-5—currently planned to begin in 2007. If DOD and the Congress determine that an extended range brigade airdrop, to a small, austere airfield is a valid need, this need could be considered in choosing a replacement airlifter for the C-5.

Further, for safety reasons, the Army has imposed a restriction on paratroopers jumping from C-17s in close airdrop formations due to turbulence created by the C-17. Until this safety concern is resolved, the C-17 cannot be used to support the brigade airdrop mission.

Although the Congress has approved and DOD has awarded a multiyear contract with an accelerated production schedule for the final 80 C-17s,

that contract contains a clause that would permit the government, if full funding for a production lot under the multiyear contract were not available, to revert to single-year options without paying cancellation costs. While there would be an increase in program discontinuation costs to close out the contract at 100 rather than at 120, those additional costs have been accounted for in our estimate of the potential savings.

Finally, DOD and McDonnell Douglas have implemented initiatives to reduce the total program cost of the 120 C-17 program. However, the current estimated cost of \$43 billion is about the same as that estimated in 1994. Although production costs have decreased, costs for planned modifications and retrofit, further testing, and contractor support of fielded aircraft have increased. In addition, the contract prices for the last 50 aircraft could increase by about \$1 billion if ceiling prices on those contracts are reached.

Principal Findings

Strategic Airlift Requirements Can Be Met With 100 C-17s

The MRS BURU recommended that, to meet strategic mobility requirements for a scenario involving two nearly simultaneous major regional contingencies, an airlift fleet with 120 to 140 C-17s, or their equivalents, be used and that afloat prepositioning be increased. The Strategic Airlift Force Mix Analysis showed that an acceptable option to meet strategic requirements was to acquire 100 C-17s and 18 commercial transport aircraft, which would save \$300 million compared with a fleet with 120 C-17s.

On the basis of GAO's analysis, a fleet with 100 C-17s and no commercial transport aircraft may also be a viable alternative that could save the government over \$7 billion in life-cycle costs as shown in table 1.

Table 1: Potential Life-Cycle Cost Savings From Acquiring 100 Instead of 120 C-17s

In millions of fiscal year 1996 constant dollars

Number of aircraft beyond 40	Acquisition costs	Military construction costs	Operating and support costs	Discontinuation costs	Total costs
80	\$16,881.7	\$ 162.0	\$19,604.0	\$ 118.0	\$36,765.0
60	12,840.1	137.0	15,820.0	360.0	29,157.1
Difference	\$4,041.6	\$25.0	\$3,784.0	\$(242.0)	\$7,608.6

This smaller fleet would provide sufficient outsize cargo carrying capability and could adequately deal with potential constraints such as reduced airfield availability and ramp space. A fleet with 100 C-17s would be sufficient if DOD implemented one or a combination of the following alternative measures:

- Increase the amount of Army combat support and combat service support materiel planned for prepositioning. For example, DOD could slightly increase the amount of prepositioned materiel planned for afloat prepositioned ships beyond that recommended in the MRS BURU.¹
- Use airlift assets not considered available in the study, such as C-17 and C-5 training aircraft and increased numbers of Civil Reserve Air Fleet aircraft.
- Extend by a day or two the time frame in which a small amount of Army combat support and combat service support materiel would be delivered during the initial phase of the Mobility Requirements Study's major regional contingencies.

Increased costs attributable to these measures would be minor when compared with the potential savings. Increased prepositioning aboard ships results in only minor cost increases since sufficient space will be available on the ships to accommodate tonnage not delivered by a fleet, including 100 C-17s. Since trainer aircraft will be part of the inventory and in use, increased costs from their use would only be the additional flying hours in direct support of the major regional contingency. The Civil Reserve Air Fleet has historically been recognized as a low cost airlift option.

Although GAO cannot estimate these costs exactly, it has accommodated them, to the extent it could identify them, in the estimate of potential savings. DOD would have to determine the effect of a delay of 1 or 2 days in delivery of a small amount of combat support and combat service support materiel to the second major regional contingency.

¹"Afloat prepositioning" is the use of ships loaded with combat equipment and support items located near potential trouble spots. This enables the ships to respond more quickly than if they were deployed from the United States. The MRS BURU recommended regenerating (reloading) these ships after their cargo has been used in an initial major regional contingency.

**100 C-17s Would Suffice
for Lesser Regional
Contingencies and
Strategic Brigade Airdrop**

The purpose of DOD's Tactical Utility Analysis was to quantify the C-17's benefits in responding to lesser regional contingencies such as humanitarian relief, peacekeeping, and peace enforcement missions; providing intratheater airlift and direct delivery to small, austere airfields; and performing a strategic brigade airdrop. The analysis found that, with the exception of an extended range brigade airdrop, 100 C-17s or fewer would be sufficient. The Tactical Utility Analysis had found that about 120 C-17s would be needed to conduct this mission directly from the continental United States to a small, austere airfield, as desired by the Army.

**Alternatives Can Be Used
to Meet Strategic Brigade
Airdrop Requirements With
100 C-17s**

The Air Force does not currently have the capability to support an extended range brigade airdrop mission as envisioned by the Army within the desired time frame. This capability will not exist until fiscal year 2004, when at least 114 C-17s are available and 50 C-5s have been modified for airdrop. The Air Force is currently considering alternatives for performing this mission. Options include moving some equipment and supplies to a base or bases closer to the targeted destination as an initial step in the airdrop mission or conducting the mission to a larger airfield accessible to the C-5. GAO believes such options would allow a fleet with 100 C-17s and 50 modified C-5s to perform the extended range brigade airdrop mission.

As of July 1996, there were 74 C-5As in the airlift fleet. The Air Force's long-range airlift modernization plan calls for replacing the C-5As beginning in 2007. The Air Force plans to begin replacing C-5As just 3 years after enough C-17s are scheduled to enter the inventory to support the Army's concept for an extended range brigade airdrop. An option that could result in saving billions would be to extend the alternative methods for accomplishing the extended range brigade airdrop—using only 100 C-17s—until C-5A replacement has begun and, if the Army's concept of operations for the extended range brigade airdrop is considered a valid requirement, consider making some of the replacements capable of airdropping equipment to replace C-17s in the equipment airdrop role. This would reduce the number of C-17s needed for airdropping equipment and make them available for the follow-on role of bringing equipment and troops into the captured small, austere airfield. The Air Force would then be able to support an extended range brigade airdrop with only 100 C-17s.

**C-17 Airdrop Capability
Not Proven**

The C-17 has not yet demonstrated the capability to safely perform a mass airdrop of personnel while flying in close formation. Due to the dangers

posed to paratroopers during their descent by the C-17's wake turbulence, the Army has not approved the use of the C-17 for this mission. Until this problem is resolved, the C-17 cannot be used to support the brigade airdrop mission. Further, the C-17 does not meet paratroop exit rate requirements when airdropping personnel along with equipment bundles, which could extend the time required for all paratroopers to get on the ground and increase their separation. Increased separation would further delay organizing troops on the ground making it more difficult to execute the mission.

Estimated Program Costs Remain at \$43 Billion and Could Increase

DOD and McDonnell Douglas have taken the following actions to reduce prices for the last 88 aircraft of a 120 aircraft program: (1) imposed competitive pressure on McDonnell Douglas through the Non-Developmental Airlift Aircraft program, (2) performed a should cost analysis to serve as a basis for negotiating lower prices for the last 88 aircraft, (3) implemented cost-reduction initiatives, (4) accelerated the procurement rate, and (5) obtained congressional approval for a multiyear procurement of the last 80 aircraft.

GAO found that these actions held total program costs for 120 C-17s to about the \$43 billion amount estimated by the Air Force in January 1994. Although production costs have decreased, costs for planned modifications and retrofit, further testing, and contractor support of fielded aircraft have increased. Also, the contract prices for the last 50 aircraft could increase. The production lots for the last 50 aircraft are covered by not-to-exceed ceiling prices, which exceed the negotiated target prices by about \$1 billion. Further, the contract provides for adjustments in the prices for the last 72 aircraft to account for changes in costs that could not be accurately foreseen at the time the multiyear contract was negotiated.

Matters for Congressional Consideration

Because of the potential savings of over \$7 billion and the relative contribution of the final 20 C-17s, the Congress may wish to consider funding only 100 C-17s and requiring DOD to reexamine the decision to acquire 120 C-17s. DOD can meet mission requirements by employing various low-cost options and by extending the use of alternatives for accomplishing the extended range brigade airdrop. Further, before approving the acquisition of the final 20 C-17s primarily to support the brigade airdrop mission, the Congress should require that DOD certify that the aircraft's wake turbulence problems have been solved.

Agency Comments and GAO's Evaluation

In commenting on a draft of this report, DOD maintained that a fleet providing the capability of 120 C-17 equivalents is the minimum fleet required based on the MRS BURU and that all of the alternatives suggested by GAO were operationally unacceptable. DOD agreed that the C-17 has a wake vortex problem and has not yet demonstrated the capability to safely perform a mass airdrop of personnel while flying in close formation.

While the MRS BURU recommended that a fleet with the capacity of 120 C-17s be acquired, the basis for that recommendation included a set of assumptions concerning the expected level of prepositioning and the timing of the scenarios. GAO is suggesting that there are measures that DOD could implement that would change those assumptions. That is, alternatives that could be used either separately or in combination to offset the need for the additional 20 C-17s. For example, increased use of Civil Reserve Air Fleet aircraft and KC-10s and the employment of C-17 and C-5 trainers all have been used as short-term solutions to meet airlift needs in the past. DOD's assertion that GAO's suggested alternatives increase risk to an unacceptable level is not based on analysis. While DOD's analyses offer increased flexibility as a rationale for acquiring 120 C-17s, they do not preclude the alternatives GAO has proposed.

DOD also recommended that GAO withdraw its suggestion that the Congress require DOD to certify that the aircraft's wake turbulence problems have been solved prior to approving acquisition of the final 20 C-17s. Since DOD agrees that there is a wake turbulence problem and that the aircraft has not demonstrated the ability to safely support a mass formation airdrop, GAO believes that the reasons for requiring such certification remain valid.

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Abbreviations

AMC	Air Mobility Command
CRAF	Civil Reserve Air Fleet
DAB	Defense Acquisition Board
DOD	Department of Defense
LMSR	Large Medium-Speed Roll On Roll Off
MRS BURU	Mobility Requirements Study Bottom-Up Review Update
NDAA	Non-Developmental Airlift Aircraft
PE/PI	Producibility Enhancement/Performance Improvement
SAFMA	Strategic Airlift Force Mix Analysis

Introduction

In the post-Cold War period, the Department of Defense (DOD) must be able to provide troops, equipment, and supplies throughout the world in response to conflicts or crises affecting U.S. interests. DOD relies on sealift, prepositioned assets, and airlift to accomplish this mission. DOD plans to use airlift to rapidly transport troops and supplies to link up with prepositioned equipment, thus speeding the deployment of heavier units early in a conflict.

Airlift is classified as either intertheater (from one theater of operation to another) or intratheater (operations within a theater). Strategic intertheater airlift services are provided by the Air Force's Air Mobility Command (AMC), which has a fleet of C-5, C-141, KC-10, KC-135, and C-17 aircraft to carry out that mission. AMC also uses the Civil Reserve Air Fleet (CRAF) to augment its military airlift capacity during contingencies. The Air Combat Command is responsible for operating C-130 aircraft, which provide intratheater airlift.

C-17 Expected to Modernize Airlift Fleet

To meet a need for additional long-range airlift, the Air Force contracted with McDonnell Douglas Corporation in July 1982 to develop and produce the C-17. The C-17 is an air refuelable, four-engine jet transport designed to operate in both the intertheater and intratheater roles. It is to replace the C-141 in the current air fleet and complement the larger but less maneuverable C-5. The C-17 is currently contracted to carry a payload of 119,125 pounds 3,200 nautical miles unrefueled and perform the full range of airlift missions, including landing on small, austere airfields; airlifting outsize cargo, such as tanks; and airdropping troops and equipment.

When the program began in 1982, the Air Force planned to acquire 210 C-17 aircraft. However, in April 1990, the Secretary of Defense, citing the post-Cold War environment and fiscal constraints, reduced the program to 120 aircraft. During development and initial production, the C-17 program experienced ongoing cost growth and technical problems and the contractor fell behind schedule in delivering the production aircraft. In December 1993, because of concerns with the C-17's growing cost and continuing technical problems, the Secretary of Defense announced that the program would be stopped at 40 aircraft unless McDonnell Douglas could demonstrate that program cost, schedule, and performance improvements warranted completing the 120 aircraft program. The contractor was given a 2-year probationary period to improve its performance.

In March 1994, DOD (at congressional direction) established a Non-Developmental Airlift Aircraft (NDAA) program to procure a transport aircraft using commercial practices as a possible alternative or supplement to the C-17. Although eight companies or teams expressed interest in providing a commercial NDAA, only one, the Boeing Company, responded to a request for proposal. Boeing proposed two variations of its 747-400F—one that included an enlarged door and a strengthened floor and an unmodified version. The Air Force named the aircraft proposed by Boeing the C-33. DOD also obtained information from the Lockheed Martin Corporation on costs for an upgraded version of the C-5, a C-5D model with improved avionics and significantly improved reliability and maintainability.

In October 1995, DOD convened a Defense Acquisition Board (DAB) to determine whether the C-17 program should be continued beyond 40 aircraft, and if so, what mix of additional C-17s and NDAA should be procured.¹ In November 1995, the Under Secretary of Defense for Acquisition and Technology announced that as a result of the DAB review, DOD planned to procure 80 more C-17s for a total of 120 and not to purchase any NDAA aircraft. In a separate action, in February 1996, the Under Secretary of Defense approved an Air Force plan for a multiyear procurement for the last 80 of the 120 C-17 buy at a maximum affordable production rate of up to 15 aircraft a year during fiscal years 1997 through 2003. The Congress approved this 7-year plan in April 1996.

In January 1994, the C-17 Program Director estimated that total program costs for 120 C-17s would be about \$43 billion in then year dollars. As of November 1996, McDonnell Douglas had delivered 29 C-17 aircraft for operational use.

Specifics of DOD Contract With McDonnell Douglas

Prior to the C-17 full-rate production decision in November 1995, the Air Force had contracted with McDonnell Douglas, under seven different production lots, for the production of 32 of the 120 C-17s that it plans to buy. As part of the program restructuring that occurred during the probationary period, the Air Force negotiated four separate sole-source contracts with McDonnell Douglas that covered aircraft production, program and product improvements, and support. Previously, the Air

¹In January 1995, we reported that because of changes in the C-17's intended role, less than anticipated performance, and continued program cost growth, the Congress should not support the C-17 program beyond the minimum number needed to fulfill unique military requirements. (See *C-17 Aircraft: Cost and Performance Issues* (GAO/NSIAD-95-26, Jan. 26, 1995).)

Force had included improvements and support tasks in the development contract or the individual contracts for the first seven production lots.

The four contracts were (1) a producibility enhancement/performance improvement (PE/PI) contract for funding projects aimed at reducing production costs and for funding C-17 performance and capability improvements; (2) a field support contract to provide for depot repair management and sustaining support to maintain fielded aircraft in operational condition (including retrofitting aircraft, repairing parts, and procuring support equipment and spare parts); (3) a single-year contract for production lot VIII, increasing the number of C-17s under contract from 32 to 40; and (4) a multiyear contract for the next 80 aircraft that increased the number of C-17s under contract from 40 to 120.

In July 1995, the Air Force awarded a cost-plus-award-fee PE/PI contract to McDonnell Douglas to fund cost-reduction initiatives that include both improvements to the aircraft such as an improved engine enclosure that costs less to build and install and improvements to the manufacturing process, which would reduce the cost to assemble the aircraft. This contract has a maximum value of \$1.1 billion. As of July 1996, the Air Force had provided the contractor about \$385 million for various PE/PI tasks under this contract. In February 1996, the Air Force awarded McDonnell Douglas the field support contract. The value of this contract as of August 1996 is \$121.6 million for the period January through December 1996.

Also, in February 1996, the Air Force and McDonnell Douglas agreed to a \$1.9 billion firm fixed-price contract for production of eight aircraft under production lot VIII, increasing the number of C-17s to be produced from 32 to 40. This contract, referred to as the lot VIII and beyond contract, also contained separate firm fixed-priced options for the next three production lots (lots IX through XI), and separate options, with not-to-exceed ceiling prices, for the remaining production lots through 120 aircraft. The contract contained a variation in quantity clause allowing for an extensive range of production schedules. The minimum and maximum production schedules allowed by this clause are shown in table 1.1.

Table 1.1: Minimum and Maximum Production Schedules Included in the Lot VIII and Beyond Contract

Fiscal year profile	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Minimum	8	8	8	8	8	8	8	8	8	8	8
Maximum	8	9	9	13	15	15	15	4			

However, as a result of the Congress approving DOD's C-17 multiyear procurement plan, the Air Force changed its C-17 procurement plan for the last 80 aircraft from the single-year contract options, included in the lot VIII and beyond contract, to a multiyear contract. The total value of the multiyear contract, dated June 1996, is \$14.2 billion and is based on an accelerated production schedule as shown in the table 1.2.

Table 1.2: Accelerated C-17 Production Schedule Included in the Multiyear Contract

Fiscal year	1997	1998	1999	2000	2001	2002	2003
Number	8	9	13	15	15	15	5

Objective, Scope, and Methodology

We undertook this review, at the request of Congresswoman Elizabeth Furse, to determine whether less costly alternatives exist to procuring 120 C-17 aircraft while still satisfying airlift requirements.

To determine whether less costly alternatives existed, we reviewed three different analyses that provided the basis for determining the number of additional C-17s to acquire beyond the 40-aircraft program. These were the Joint Chiefs of Staff's 1995 Mobility Requirements Study Bottom-Up Review (MRS BURU); the Strategic Airlift Force Mix Analysis (SAFMA), completed by AMC; and the Tactical Utility Analysis undertaken by DOD's Director, Program Analysis and Evaluation. We met with representatives of the Joint Chiefs of Staff Logistics Directorate, AMC, and DOD to discuss the results of the studies and obtain the underlying support, assumptions, and methodologies used in performing each of these analyses. We were also briefed by representatives from Boeing and Lockheed Martin on their NDAA aircraft proposals.

To assess the Air Force's and McDonnell Douglas's efforts to reduce C-17 costs, we analyzed the Air Force's 1994 C-17 should cost review and the Air Force and McDonnell Douglas's cost-reduction initiatives for the production lot VIII contract and multiyear contract for the last 80 C-17 aircraft. In performing this work and analyzing the technical performance of the C-17, we interviewed officials from the C-17 program office; the NDAA program office; McDonnell Douglas; the Air Force Operational Test and Evaluation Center; and DOD's Office of the Director, Operational Test and Evaluation.

We also met with representatives from the Army's Director of Requirements, Office of the Deputy Chief of Staff for Plans and Operations; AMC; and the Air Force's Deputy Chief of Staff for Plans and

Chapter 1
Introduction

Operations, Mobility Forces Division to discuss the strategic brigade airdrop concept of operations.

We performed our audit between February 1995 and October 1996 in accordance with generally accepted government auditing standards.

C-17 Defense Acquisition Board Decision

The decision to purchase more than 40 C-17s was based on reports showing first, that the aircraft and McDonnell Douglas had met the cost, schedule, and aircraft performance criteria required to continue production beyond 40 aircraft and second, that C-17 operational testing rated the aircraft operationally effective and suitable. The decision to acquire 120 C-17s and no NDAA was based on the DAB's conclusion that 120 C-17s would provide a greater degree of flexibility at an increased cost of only \$300 million over the mixed fleet option the DAB considered acceptable—100 C-17s and 18 C-33s (modified Boeing 747-400Fs).¹ Specifically, the DAB found that the 120 C-17 option would (1) provide a hedge against the potential reductions in the amount of cargo delivered due to such things as reduced airfield availability, ramp space, and services and (2) maximize the benefits provided by the military capabilities of the C-17, which are not possessed by the C-33 (a commercial air transport).

C-17 Program Showed Needed Improvement

In November 1994, DOD established evaluation criteria for the C-17 full-rate production decision by the DAB. These included (1) acceptable dates for completing development and operational testing and establishing initial C-17 operational capability, (2) the level of acceptable cost performance for the approved 40-aircraft program, and (3) the key aircraft performance indicators that would need to be met. These criteria generally included an objective criterion (a goal that DOD would like to have seen achieved) and a threshold criterion (a minimal performance expectation below which the program would be in danger of being canceled). For example, an objective was established to declare initial operational capability by January 1995; a threshold of July 1995 was established for this event. DOD met the objective, declaring initial operational capability in January 1995.

The C-17 Program Manager reported to the DAB that the C-17 program had successfully met the criteria for cost, schedule, and contractor and aircraft performance that DOD had established in order for the program to proceed beyond 40 aircraft. (See app. I for a complete listing of the criteria.) He also reported that the Air Force and McDonnell Douglas had negotiated significantly lower prices for production lot VIII and the remaining production lot options to complete the 120-aircraft program.

Results of C-17 Operational Testing

As a result of a multiservice initial operational test and evaluation, the Air Force Test Director reported that the C-17 was operationally effective and

¹Life-cycle costs stated in fiscal year 1996 dollars.

suitable and met or exceeded all the key aircraft performance parameters established for the DAB.

Although the Test Director informed the DAB that the C-17 was operationally effective and suitable, he also identified areas needing improvement. These included (1) overcoming Army safety concerns that preclude paratroopers from jumping from C-17s flying in close formation and meeting established performance criteria for paratroop and equipment bundles exiting the aircraft during personnel airdrops;² (2) redesigning the litter capacity and fixing various oxygen equipment problems needed in order to perform the aeromedical evacuation mission; (3) correcting inadequacies with the aircraft's mission computer and associated operating manuals, which caused the mission computer to fail repeatedly, thereby increasing pilot workload; and (4) fixing inadequacies with the aircraft's integrated diagnostics causing high rates of false failure indications or failures that could not be duplicated.

Results of the DAB

Determining the appropriate C-17/NDAA mix was a primary goal of the DAB. That determination was based on the following analyses:

- The Joint Chiefs of Staff's MRS BURU which established a strategic airlift requirement for supporting two nearly simultaneous major regional contingencies.
- The SAFMA, an AMC study of possible airlift force mix options that could meet the strategic airlift capability recommendations of the MRS BURU.
- The DOD Tactical Utility Analysis designed to quantify the benefits of using (1) C-17 capabilities such as landing on austere airfields and airdropping cargo and troops and (2) the C-17s strategic airlift capabilities in support of lesser regional contingencies not modeled in the MRS BURU.

The Strategic Airlift Requirement

The MRS BURU study made recommendations regarding strategic mobility requirements, including airlift. The study's objectives were to determine the capability of the fiscal year 2001 programmed strategic mobility forces to deploy and sustain combat and support forces, identify shortfalls in that capability, and recommend solutions to eliminate identified shortfalls. Employing a baseline airlift fleet projected for the year 2001 that included C-17s, C-141s, C-5A/Bs, KC-10s, KC-135s, and CRAF, the MRS BURU estimated the mobility requirements for the initial halting phase of four

²The Army imposed this restriction because the air turbulence created in the wakes of C-17s flying in close airdrop formation poses risks to paratroopers jumping from following aircraft.

different scenarios involving either a single major regional contingency or two nearly simultaneous major regional contingencies.³

The most demanding MRS BURU scenario, for which additional airlift capacity was recommended, was one involving two nearly simultaneous major regional contingencies. To meet the strategic mobility requirements for this scenario, the MRS BURU recommended additional afloat prepositioning and, after the retirement of C-141s, an airlift fleet with the capacity of between 120 and 140 C-17s. This fleet would provide a delivery capability between 49.4 and 51.8 million ton-miles per day.⁴ The MRS BURU did not recommend a particular type of aircraft to meet its recommended airlift capability. The DAB would later make this decision based on the results of the SAFMA.

SAFMA

The SAFMA compared the relative performance of mixed fleets with C-17s and NDAA against fleets with 120 C-17s and 140 C-17s to determine which mixed fleets could meet the airlift performance capability of a fleet with 120 or 140 C-17s during the MRS BURU's most demanding scenario. This analysis also evaluated the cost-effectiveness of each of the fleet alternatives.

DOD developed a detailed listing of equipment, munitions, and supplies that would be airlifted using the MRS BURU recommended airlift requirements. It then modeled the operations of the strategic airlift fleet during the initial phases of the two major regional contingencies scenario. Air refueling and delivery to locations other than main operating bases were not considered in the SAFMA.

AMC used an airlift fleet with 120 C-17s as its primary performance criteria in the SAFMA. To be acceptable, mixed fleets of C-17s and C-33s had to deliver as much or more outsize, oversize, and bulk cargo as an airlift fleet with 120 C-17s.⁵ The force mix evaluations began with 40 C-17s and progressed in squadron size intervals up to 140 C-17s. The Lockheed C-5D

³The halting phase is the initial phase of a major regional contingency during which the advance of an enemy force is halted and the loss of territory and critical facilities is minimized.

⁴Million ton-miles per day is an aggregate, unconstrained measure of airlift capacity. It is based on aircraft utilization rate, average ground speed, average payload weight, and a standard productivity measure. This measure does not take into account the type of the payload, airfield limitations such as runway and parking ramp size, and aircraft ground servicing time.

⁵Outsize cargo, such as Apache helicopters and M1 Abrams tanks, can be carried only by the C-17 and C-5. Oversize cargo exceeds the dimensions of a 463L pallet but is smaller than outsize. Examples include 2-1/2 ton trucks and Bradley Fighting Vehicles. Bulk cargo, such as ammunition and food, will fit on a 463L pallet.

was evaluated only at the 40 C-17 quantity breakpoint (40 C-17s and 50 C-5Ds). The final SAFMA combinations of C-17s and C-33s are shown in table 2.1.

Table 2.1: Force Mix Options Considered in the SAFMA

	40	58	72	86	100	120	132	140
C-17	40	58	72	86	100	120	132	140
C-33	56	42	30	30	18	0	18	0

The SAFMA study found that within the scope of fleet mixes being actively considered (up to 120 C-17s) only two of the mixed fleet alternatives, one with 86 C-17s and 30 C-33s and another with 100 C-17s and 18 C-33s, performed as well or better than a fleet with 120 C-17s. These mixed fleets delivered as much outsize cargo but more oversize and bulk cargo than a fleet with 120 C-17s. For example, a fleet with 100 C-17s and 18 C-33s delivered 5,000 more tons of oversize cargo and about 2,000 more tons of bulk cargo in the required time frame. A fleet with 40 C-17s and additional C-5Ds would not deliver as much outsize cargo as an airlift fleet with 120 C-17s.

The AMC cost analysis showed the potential savings from the acceptable mixed fleet options ranged from \$300 million in fiscal year 1996 dollars for a mixed fleet of 100 C-17s and 18 C-33s to \$1.85 billion for a fleet of 86 C-17s and 30 C-33s.

Airfield Constraints Favor C-17s

The SAFMA also addressed the impact of airfield constraints due to reduced airfield availability, ramp space, and services; and other limitations on the number of aircraft that can be accommodated and serviced on the ground at one time. The term maximum on ground refers to the maximum number of aircraft on the ground that can be parked, unloaded, and serviced in a given time period. In this regard, the MRS BURU and SAFMA studies assumed a moderate maximum on ground, a reduced level of capability based on the experience of Desert Shield/Desert Storm, AMC operation plans, and maximum on ground assumptions used in a C-17/NDAA cost and operational effectiveness analysis completed by the Institute for Defense Analyses in December 1993. Constrained maximum on ground conditions favored the more maneuverable C-17 over the larger C-33 aircraft.

Maximum on ground constraints and uncertainties were an important consideration in the DAB's decision to procure 120 C-17s. As part of the force mix analysis, AMC examined the impact of reducing maximum on

ground below the levels assumed in the MRS BURU. AMC found that force mixes with more than 100 C-17s offered a better hedge against uncertainties about airfield availability, congestion, and ground support. For example, when maximum on ground values were reduced by 15 percent in Northeast Asia during the halting phase, all fleet options delivered less outsize cargo than the MRS BURU-established requirement, but an airlift fleet with 120 C-17s delivered more of the outsize cargo than the mixed fleets.

Tactical Utility Analysis

In preparation for the November 1995 C-17 DAB, DOD also wanted to ensure that the planned analysis for the DAB recognized the potential benefits of the military capabilities of the C-17 that could not be provided by a NDAA. In December 1994, the Under Secretary of Defense for Acquisition and Technology directed DOD's Director, Program Analysis and Evaluation, in concert with the Army and the Air Force, to complete a Tactical Utility Analysis. This analysis was to quantify the C-17's benefits in responding to lesser regional contingencies such as humanitarian relief, peacekeeping, and peace enforcement missions; providing for intratheater delivery and direct delivery to austere airfields; and performing a strategic brigade airdrop. These capabilities were not addressed in the work done in the SAFMA.

The Tactical Utility Analysis found that the most demanding of the lesser regional contingencies was the peace enforcement mission. This mission, as modeled in the study, could be accomplished with varying numbers of C-17s. The analysis showed that as more C-17s were provided less total time was required to deliver troops and equipment. According to the study leader, in the peace enforcement scenario, there were no time requirements and the delivery time saved was not critical to completing the mission. Also, the analysis showed that the time saved between the 86 and 120 C-17 fleet levels was only a few days.

The Tactical Utility Analysis also evaluated the use of the C-17 in an intratheater airlift role. It indicated that a squadron of aircraft dedicated specifically to this role might be beneficial. However, study analysts acknowledged that these aircraft would be in addition to the 120 C-17 equivalents the MRS BURU found were required for strategic airlift. There is no requirement for using C-17s in an intratheater role in DOD's fiscal years 1998 to 2003 Defense Planning Guidance. The Joint Chiefs of Staff completed a study of intratheater airlift needs and concluded that one squadron of C-17s dedicated to the intratheater mission would be useful.

However, that study recommended further analysis of the issue. The Air Force is currently conducting additional intratheater airlift analyses. That analysis is planned to be completed in late spring 1997.

Lastly, the Tactical Utility Analysis evaluated the need for C-17s to accomplish a strategic brigade airdrop. On the basis of the then existing Defense Planning Guidance, which called for a limited strategic range capability, an airlift fleet with 100 C-17s, along with modified C-5s, would be sufficient to accomplish this mission. The Tactical Utility Analysis, however, also analyzed the number of C-17s that would be used to conduct an extended range brigade airdrop. It found that acquiring 120 C-17s would allow the Air Force to support a strategic brigade airdrop directly from the continental United States to a small, austere airfield located beyond the range required by the Joint Chiefs of Staff at the time of the C-17 DAB.

DAB Determination

The DAB determined that the C-17 program and McDonnell Douglas's performance had improved sufficiently to warrant continued production of the C-17. From the options considered, the DAB found two acceptable options that would provide sufficient strategic airlift capability and a minimum of 100 C-17s to perform the strategic brigade airdrop mission analyzed in the Tactical Utility Analysis. These were 120 C-17s and no NDAA and 100 C-17s and 18 NDAA. The DAB chose the 120 C-17 option because of the relatively small savings from acquiring a mixed fleet—\$300 million in life-cycle costs—and the advantages in increased flexibility from acquiring 20 additional C-17s.

Less Expensive Options for Meeting Requirements Could Save Billions

Our analysis of the strategic airlift requirement defined in the MRS BURU and the information developed in the SAFMA and the Tactical Utility Analysis indicate that DOD could save over \$7 billion (fiscal year 1996 dollars), by acquiring and operating an airlift fleet with 100 C-17s and no NDAA. With 100 C-17s and the remaining airlift fleet of C-5s, KC-10s, KC-135s, and CRAF, lower cost options exist to meet strategic airlift requirements. These include small increases in the amount of materiel prepositioned afloat, the use of airlift aircraft assumed not to be available in the MRS BURU, or the use of a slightly longer delivery time frame on some combat support and combat service support materiel. Increased costs attributable to these lower cost options and to discontinuing the program at 100 rather than 120 C-17s have been accommodated in our estimate of savings.

Further, although DOD revised its Defense Planning Guidance in April 1996 to require an extended range strategic brigade airdrop, options also exist to meet this requirement, although not necessarily as identified in the Army's concept of operations. The Army's concept of operations envisions accomplishing the extended range brigade airdrop from the continental United States directly to a small, austere airfield.¹ However, an extended range brigade airdrop to a small, austere airfield is not specifically required by the current Defense Planning Guidance and cannot be supported with the Air Force's current airlift fleet.

According to the Tactical Utility Analysis, performing the extended range airdrop mission as envisioned by the Army will require at least 114 C-17s. The Air Force is currently exploring alternatives to meet the requirement until 114 C-17s can be fielded in 2004.

Although the Congress has approved and DOD has awarded a multiyear contract with an accelerated production schedule for the final 80 C-17s, that contract contains a clause that would permit the government to revert to a contract with single-year options, allowing for variations in quantity, if a production lot under the multiyear contract is not fully funded. While there is an increase in program discontinuation costs to close out the program at 100 rather than 120 aircraft, those additional costs have been accounted for in our savings estimate.

¹The Air Force defines a "small, austere airfield" as one with limited taxiway, ramp space, and services. Runways, paved or semi-prepared, are occasionally longer than 5,000 feet, but are usually less than 4,000 feet and normally 60 to 110 feet wide.

100 C-17s Can Meet Strategic Mobility Requirements

In the MRS BURU, the Joint Staff identified a small, potential airlift shortfall in the capability of mobility forces to deliver the total tonnage of unit equipment scheduled for delivery early in the halting phases of two nearly simultaneous major regional contingencies. The shortfall was about 4 percent of the unit equipment tonnage delivered. According to the Army's Office of the Assistant Deputy Chief of Staff for Operations and Plans, this shortfall is marginal. It occurred in only one of the two major regional contingencies and consisted of prepositionable combat support and combat service support materiel. To deliver the entire shortfall by air would have required more than 140 C-17 equivalents. The study, however, recommended that a portion of the shortfall be prepositioned afloat and that the remainder be airlifted into the theater. The solution recommended in the MRS BURU required at least 120 C-17s, or the equivalent capacity provided by a mix of C-17s and NDAA.

With some additional measures, an airlift fleet with 100 C-17s could provide sufficient airlift capability, including the delivery of outsize cargo, to meet the MRS BURU mobility requirements. These include (1) slightly increasing prepositioning, for example, by placing the shortfall not delivered by 100 C-17s on prepositioned ships when regenerating these ships between the two major regional contingencies; (2) using airlift assets that were assumed not to be available in the MRS BURU; (3) increasing slightly the time frame in which the MRS BURU shortfall would be delivered; or (4) adopting a combination of these measures.

Further, an airlift fleet with only 100 C-17s also provides a hedge against a more constrained airfield environment than that modeled in the MRS BURU. A sensitivity analysis done as part of the force mix analysis showed that under a more constrained airfield environment, an airlift fleet with 100 C-17s delivered only 3 percent, about 500 tons, less outsize cargo than a fleet with 120 C-17s.

Additional Afloat Prepositioning Would Reduce the Airlift Requirement

Prepositioning heavy combat equipment and supplies, both ashore and afloat, can greatly reduce both the time required to deploy forces to distant regions and the number of airlift sorties devoted to moving such supplies. Afloat prepositioning is a flexible means of transporting materiel to where it is needed in a contingency. Ships loaded with combat equipment and support items are located near potential trouble spots, enabling them to respond more quickly than if they were deployed from the United States. As a result of the Bottom-Up Review in October 1993,

DOD expanded the amount of planned prepositioning needed for two nearly simultaneous major regional contingencies.

According to DOD, the MRS BURU reconfirmed the validity of the Bottom-Up Review and the programs under way to meet those requirements. Besides verifying that expanded prepositioning of heavy Army equipment in the Persian Gulf and Korea was warranted, the MRS BURU recommended the addition of 15,000 tons of afloat prepositioning and other prepositioning measures to support the Army's afloat prepositioning program.

Although the MRS BURU recommended airlifting a portion of the 4-percent materiel shortfall, it found that the entire shortfall could be delivered to the theater on afloat prepositioning ships. Our review indicates that the additional prepositioning needed, in conjunction with an airlift fleet with only 100 C-17s, would add only about a half percent to the 4-percent materiel shortfall identified and the increased afloat prepositioning already assumed to be necessary in the MRS BURU. Sufficient space will be available on the Army's prepositioned ships to accommodate tonnage not delivered by an airlift fleet with 100 C-17s.

The 1992 Mobility Requirement Study recommended the addition of 19 Large Medium-Speed Roll On Roll Off (LMSR) ships to accommodate the requirement for increased lift capability needed to support a two major regional contingency scenario. Five of the ships are to be refurbished, and 14 are to be newly acquired. The MRS BURU recommended that several of the new ships be used to support afloat prepositioning of Army materiel for use in the major regional contingencies and that others be used to provide a surge sealift capability. The MRS BURU recommended prepositioning ships would have about 3.5 million square feet of cargo space. According to planning factors used by the Army, these ships can be loaded to 80 percent of capacity. As a result, there will be about 2.8 million square feet of space available for prepositioned materiel.

Current planning calls for the use of about 2 million square feet for a brigade set of equipment and additional combat support and combat service support materiel. There will also be space needed for some other planned prepositioned materiel besides the amount we are recommending. While the exact numbers are classified, the additional materiel and our recommended additional prepositioned materiel can be accommodated in the 800,000 square feet of available space on the LMSRs recommended by the MRS BURU for afloat prepositioning.

The MRS BURU's general officer steering committee rejected an option to preposition the entire 4-percent shortfall. In its opinion, this alternative would limit a theater commander's flexibility to adjust the planned flow of equipment and materiel into the theater. However, there is only about 2 percent of the planned force affected by the proposed increased prepositioning. Therefore, the 120 C-17 equivalents solution would increase a theater commander's flexibility to change the structure of the force by only about 2 percent over what it would be if the entire shortfall was prepositioned. This limited increase in flexibility would come at a significant increase in cost.

Additional Airlift Aircraft Are Available

Another option to alleviate the small shortfall in combat support and combat service support materiel would be to use aircraft that were assumed not available in the MRS BURU. These include training aircraft (C-5s and C-17s), additional KC-10s, and increased CRAF assets.

In the MRS BURU, eight C-17s and six C-5s set aside for training purposes were not used for strategic airlift. A DOD official told us that, for planning purposes, training aircraft are assumed not to be available to support contingencies. However, U.S. Transportation Command officials stated that, in a two nearly simultaneous major regional contingency scenario such as that envisioned in the MRS BURU, it is likely that these aircraft would be used. Training aircraft, for example, were used in Operation Desert Shield/Desert Storm to enhance strategic airlift capability.

The 59 KC-10s in AMC's airlift fleet are dual-role aircraft, performing both cargo-carrying and aerial refueling missions. Only 37 of the 59 KC-10s in the Air Force inventory are dedicated to strategic airlift. In a two-major regional contingency scenario, however, DOD would have the option of using some of the remaining KC-10s to supplement the airlift flow. U.S. Transportation Command officials told us that, in such a contingency, they would consider using more KC-10s to provide strategic airlift. However, these officials also pointed out that these aircraft would be available only if they were not needed for aerial refueling.

The CRAF program is more robust than assumed in the MRS BURU, and additional CRAF aircraft would be available to deliver cargo during a two major regional contingency scenario. The CRAF capacity under contract for 1996 is 19.50 million ton miles per day, which is about 1 million ton miles per day greater than projected in the MRS BURU. The Secretary of the Air

Force has reported that, although future years' commitments are not certain, the calendar year 1996 level is sustainable.

In addition to these aircraft, a number of military airlifters are held in reserve during contingencies for other priorities as determined by the Joint Chiefs of Staff. In the MRS BURU and SAFMA studies, operational C-5s and C-17s were withheld to carry out other airlift missions (such as providing presidential support). If needed, the Joint Chiefs would have the option of using CRAF aircraft or KC-10s and KC-135s to fulfill some of these missions, thus freeing the more effective military airlifters to meet contingency requirements.

Extend MRS BURU Time Frame Slightly

Another alternative that could reduce the need for C-17s would be to slightly extend the time frame required in the MRS BURU to deliver the small remaining shortfall in Army materiel. The Joint Staff considered an option to increase the warning time between the start of deployment and the onset of hostilities as a way to eliminate the shortfall. They rejected this option, however, because of the reduced flexibility it would provide to respond if the assumption was not valid.

The Joint Staff did not consider extending the time frame to deliver the Army equipment once hostilities commenced. The Joint Staff did not model an alternative with 100 C-17s and therefore did not provide a specific number of days by which this materiel would be delayed in arriving in the theater of operations. On the basis of our analysis of data from the SAFMA, we estimate that the delay would be 1 to 2 days. Further, since the Army characterized the shortfall as marginal, a slightly increased delivery time might not significantly affect war-fighting capability. However, this determination would have to be made by DOD based on its war-fighting models.

100 C-17s Provides Sufficient Outsize Cargo Capability

An airlift fleet with 100 C-17s would provide sufficient outsize capacity to meet the MRS BURU requirements. The delivery of outsize cargo is important because a large part of most combat units' fighting power consists of outsize cargo. Only the C-17 and the C-5 are designed to carry outsize loads. AMC, on the basis of a sensitivity analysis done in conjunction with the SAFMA, found for example, that in a projected Korean scenario, an airlift fleet with 120 C-17s, while delivering around 4,400 tons in total cargo, only delivered about 250 more tons of outsize cargo during the halting phase than a fleet with 100 C-17s.

The relatively small difference in outsize cargo delivered is due to the outsize cargo capacity of the C-5s. With only 100 C-17s available, C-5s were able to compensate for the loss of 20 C-17s and carry the vast majority of the outsize tonnage delivered by a fleet with 120 C-17s in an equivalent time frame.

**Dealing With Maximum on
Ground Constraints**

Major factors in the DAB's decision to procure 120 C-17s were maximum on ground constraints and uncertainties. The Air Force showed the DAB that, compared with mixed fleets of C-17s and NDAA, an airlift fleet with 120 C-17s could deliver more cargo within the required time frame when maximum on ground was constrained below the already reduced levels assumed in the MRS BURU. However, in Korea, the more maximum on ground constrained theater, an airlift fleet with 100 C-17s delivered only 3 percent less outsize cargo and 2 percent less oversize and bulk cargo than 120 C-17s under the more constrained maximum on ground reductions.

In a sensitivity analysis accompanying the SAFMA, AMC compared the ability of various airlift fleet alternatives to meet the required delivery timeline when maximum on ground was reduced by 15 percent in one theater. The analysis showed that a fleet with 120 C-17s performed slightly better in delivering outsize cargo during the halting phase of a Korean contingency than did the mixed fleet alternatives. Under these same maximum on ground constraints, an airlift fleet with 100 C-17s carried only about 3 percent less outsize cargo (500 tons) and 2 percent less oversize and bulk cargo (1,700 tons) than a fleet with 120 C-17s. Delaying this amount of outsize cargo would add about one day to the scenario's cargo delivery timeline.

**Options for Meeting
Strategic Airlift
Requirement Will Increase
Some Costs**

The SAFMA, conducted by AMC, developed life-cycle cost comparisons for each of the force mixes to be considered by the DAB. Based on those cost comparisons, acquiring and operating 60 rather than 80 C-17s beyond the 40 that were already committed to prior to the DAB decision would save about \$7.6 billion as shown in table 3.1.

Chapter 3
Less Expensive Options for Meeting
Requirements Could Save Billions

Table 3.1: Potential Life-Cycle Cost Savings From Acquiring 60 Instead of 80 C-17s

In millions of fiscal year 1996 constant dollars

Number of aircraft	Acquisition costs	Military construction costs	Operating and support costs	Discontinuation costs	Total costs
80	\$16,881.7	\$ 162.0	\$19,604.0	\$ 118.0	\$36,765.0
60	12,840.1	137.0	15,820.0	360.0	29,157.1
Difference	\$4,041.6	\$25.0	\$3,784.0	\$(242.0)	\$7,608.6

In addition to potential discontinuation costs (costs of terminating the program), implementing several of the individual measures that would be needed to meet the MRS BURU requirement, along with an airlift fleet having 100 C-17s, would require some additional expenditures. The additional costs that would result from increased prepositioning would vary depending on the prepositioning method chosen. In our example, the increased prepositioning would be part of the planned afloat prepositioning regeneration recommended by the MRS BURU. Since space is available on the planned LMSR ships, the costs would only be those needed to maintain the materiel during the period it is prepositioned.

On the basis of planning factors used by DOD to estimate the average cost of maintaining prepositioned materiel afloat, we estimate this cost to be less than \$1 million. If DOD chose to preposition the materiel on land, these costs would be greater because materiel would have to be procured for prepositioning and maintained for its estimated useful life. We estimate that acquiring the needed materiel would cost about \$43.3 million (on the basis of our extrapolation of Army estimates of acquiring the types of materiel that make up the MRS BURU shortfall) and maintaining the materiel for its useful life would be about \$166.4 million (based on Army planning factors for the maintenance of prepositioned materiel) for a total of \$209.7 million. We estimate, therefore, that the potential life-cycle cost savings from acquiring 100 rather than 120 C-17s would range from \$7.6 billion (\$7,608.6 million less the cost of increased afloat prepositioning) to \$7.4 billion (\$7,608.3 million less the estimated cost of prepositioning on land).

There are also some increased costs associated with the use of trainer aircraft or the increased use of CRAF. These costs, however, should not be significant since trainer aircraft are already allotted a certain level of flying hours. The cost increase would only be the additional flying hours needed to support a surge rate for the scenario. The increased CRAF costs would

depend on the extent of additional use and the agreed-on contract prices in effect at the time of the contingency. Since we cannot estimate how many additional flying hours or additional CRAF flights would be needed or the trade-off in costs between these options and the prepositioning options, we are assuming that the increased use of trainers and of CRAF would be offset by decreases in the additional prepositioning costs we estimated.

Tactical Utility Analysis Indicates That 100 C-17s Are Sufficient

The Tactical Utility Analysis, which quantified the benefits of the military capabilities of the C-17, considered the use of the C-17 in responding to lesser regional contingencies ranging from humanitarian relief to peace enforcement missions, providing intratheater airlift and direct delivery capability, and performing the strategic brigade airdrop mission required at the time of the DAB. While the Tactical Utility Analysis identified the number of C-17s that could be used in a variety of scenarios with the commensurate benefits, it found that the most demanding mission it evaluated in terms of the number of C-17s required was the strategic brigade airdrop. The analysis reported that about 100 C-17s along with modified C-5s would be required to perform the then defined limited range strategic brigade airdrop.

The Tactical Utility Analysis also determined that acquiring a fleet of 120 C-17s, along with modifying C-5s, would provide the capability to conduct an extended range brigade airdrop directly from the continental United States to a small, austere airfield. The extended range brigade airdrop was subsequently (April 1996) included as a requirement in the Defense Planning Guidance for fiscal years 1998 to 2003. However, the requirement does not specify that the airdrop will be to a small, austere airfield. The Air Force will not have the airlift capability to carry out this mission to a small, austere airfield, as envisioned by the Army, until fiscal year 2004 when at least 114 C-17s will have been delivered.

Air Force and Army officials are currently evaluating alternatives to perform this mission with fewer numbers of C-17s. Options, including staging from forward operating bases and using C-5-capable airfields for airland missions, would allow the Air Force to conduct an extended range brigade airdrop with 100 C-17s. Further, the C-17's ability to perform a strategic brigade airdrop has not yet been demonstrated under operationally realistic conditions.

**100 C-17s Sufficient for
Lesser Regional
Contingencies**

While deterring and defeating major regional aggression is the most demanding scenario identified in the United States' post-Cold War defense strategy, U.S. forces may be involved in operations short of declared or intense war. These lesser regional contingencies include peace enforcement, peacekeeping, humanitarian assistance, and noncombatant evacuation operations. Sufficient airlift is needed to transport and resupply combat forces involved in such missions.

The Tactical Utility Analysis evaluated the ability of mixed airlift fleets of C-17s and NDAA to support lesser regional contingency operations. The study found that airlift fleets with between 40 and 100 C-17s would be sufficient to support the scenarios identified in the fiscal years 1996-2001 Defense Planning Guidance.

The most demanding lesser regional contingency missions for airlift are peace enforcement missions. DOD officials told us that an airlift fleet with 100 C-17s and no NDAA would be within the range of acceptable mixes to meet airlift requirements for these missions.

**Intratheater and Direct
Delivery Airlift Needs Can
Be Met With 100 C-17s**

The Tactical Utility Analysis analyzed opportunities for using the C-17 to provide intratheater lift to complement the C-130 fleet during a major regional contingency. The study director told us that an airlift fleet with 100 C-17s could complement the C-130 fleet in providing intratheater lift, on an ad hoc basis, without significantly impacting the strategic airlift flow, particularly after the halting phase. The use of the C-17 to perform strategic airlift combined with intratheater shuttle missions is consistent with the aircraft's concept of operations, which envisions the C-17 performing intratheater shuttle missions as a leg of a return flight before returning to the strategic airlift flow. A recent RAND study also showed that combining strategic airlift missions with intratheater shuttle missions is an alternative to dedicating C-17 aircraft solely to intratheater lift.

Direct delivery to other than main operating bases was not used in the MRS BURU and SAFMA. On the basis of the Tactical Utility Analysis, 100 C-17s would be more than would likely be required for directly delivering equipment and supplies from onload points to airfields closer to their final destinations in the MRS BURU scenarios.

**Strategic Brigade Airdrop
Requirement**

At the time of the November 1995 C-17 DAB, DOD's Defense Planning Guidance required the Air Force to have the airlift capability to support a

limited range strategic brigade airdrop. The Tactical Utility Analysis showed that an airlift fleet with 100 C-17s, along with modified C-5s, could meet this requirement. In April 1996, however, DOD incorporated an extended range strategic brigade airdrop requirement in its Defense Planning Guidance for fiscal years 1998 to 2003.

The Army's concept of operations for an extended range brigade airdrop envisions accomplishing the mission from the continental United States directly to a small, austere airfield. The Tactical Utility Analysis found that acquiring 120 C-17s would provide sufficient capability to accomplish the extended range brigade airdrop. However, because the Air Force will not have a sufficient number of C-17s available to perform both airdrop and airlift missions until 2004, the Air Force is exploring alternatives that will enable it to support this mission in the interim.

Alternatives for supporting the extended range brigade airdrop with less than 120 C-17s include (1) staging a portion of the brigade at locations closer to the final destination and (2) using C-5s and C-17s to perform the airlift portion (bringing in follow-on troops and equipment) of the mission into larger airfields.

Army's Extended Range Brigade Airdrop Concept of Operation

Prior to the Tactical Utility Analysis, the Army had not clearly defined the strategic brigade airdrop's required personnel, equipment, and supplies, nor had AMC determined the airlift capability needed to deliver that force. In support of the analysis, the Army reported that it would use a medium-sized airborne brigade as the baseline force for planning this mission. The Army's concept of operations envisions the deployment of an airborne brigade in two phases. First, the Army would airdrop 2,552 paratroopers, 116 wheeled vehicles, 10 Sheridan tanks, 18 105mm howitzers, and 54 equipment bundles. Second, within 24 hours, additional aircraft would land at the captured airfield to deliver the balance of the brigade, about 690 more troopers, and 224 wheeled vehicles, 28 helicopters, along with 33 equipment and supply pallets. According to AMC, 43 C-17 missions would be needed to deliver the airlift follow-on force into a small, austere airfield.

The Army foresees using the strategic brigade airdrop capability, mainly in third world areas, to capture a small, austere airfield. The Army would prefer to conduct both the airdrop and airlift portions of the mission directly from the continental United States, without staging at locations near the final destination. Army officials believe that they would be better

able to maintain an element of surprise by staging an airborne assault directly from the United States.

The decision to define the mission as capturing a small, austere airfield limits the follow-on deliveries to C-17s from strategic distances, or C-130s and C-17s if staging is used. However, the current Defense Planning Guidance does not require a small, austere airfield capability for the extended range airdrop mission.

AMC, in support of the Tactical Utility Analysis, used the Army's concept of operations to determine the number of C-17s and other aircraft needed for an extended range strategic brigade airdrop. According to AMC's analysis, delivering the medium-sized brigade directly from the continental United States to an airfield beyond Central America or the Caribbean requires 114 C-17s plus 50 modified C-5s. The C-5's role would be limited to airdropping equipment. Since the Army's concept of operations envisions the capture of a small, austere airfield, C-5s are assumed not to be suitable for the airland mission.

Options to Meet Army Brigade Airdrop Requirement With 100 C-17s

The Air Force does not currently have the capability to airdrop the medium-sized brigade, defined above, over an extended distance to an austere airfield within the Army's specified time requirement. The Air Force will not possess such a capability until fiscal year 2004, when at least 114 C-17s will be available and 50 C-5s have been modified for airdrop.² The Air Force is currently devising other methods to meet the Army's requirement.

Options to enable the Air Force to support an extended range brigade airdrop with 100 C-17s include (1) moving a portion of the brigade's equipment and supplies to bases closer to their final mission destination as an initial step in the mission and (2) using C-5s to conduct some of the airland missions to a larger C-5-capable airfield.

From forward bases, the Air Force could recycle some of the C-17s participating in the initial airdrop to do follow-on airland missions. According to AMC analysis, about 15 of the 43 C-17 airland missions would have to be conducted from closer bases with a fleet of 100 C-17s. Alternatively, C-5s could be used to carry out some of the airland missions. C-5s are operationally restricted in wartime to landing on runways measuring at least 5,000 feet long by 90 feet wide.

²Of the 114 C-17s, 10 are spares to replace nonmission capable aircraft, 7 are needed to ensure an 80-percent probability of mission success, and 10 are assumed to be undergoing maintenance.

We discussed the potential use of forward bases with both the Army and the Air Force. The Army's representatives said that the Army had not yet evaluated the use of forward bases in support of an extended range brigade airdrop. AMC analysts did not evaluate the use of forward bases in the modeling it did in support of the Tactical Utility Analysis, but they plan to explore the concept as a way to meet the strategic brigade airdrop requirement before fiscal year 2004.

The Air Force does not plan to use the 74 C-5As to support the strategic brigade airdrop mission because they are not considered sufficiently reliable. As of July 1996, 16 of the 74 C-5As in the airlift fleet were undergoing depot maintenance or used for training purposes. The Air Force's long-range airlift modernization plan calls for replacing the C-5As beginning in 2007. Making at least some of the C-5A replacements capable of airdropping equipment to replace some C-17s in the airdrop role would provide the Air Force the capability to conduct an extended range strategic brigade airdrop with an airlift fleet having only 100 C-17s. On the basis of AMC's analysis, assuming an airlift fleet with 100 C-17s, using airdrop capable C-5A replacements in place of 16 C-17s to airdrop heavy equipment would eliminate the need to recycle C-17 aircraft from the airdrop to the airland role. This would allow the Air Force to conduct an extended range airdrop directly from the continental United States to a small, austere airfield within the specified time frame.

C-17's Ability to Perform Strategic Brigade Airdrop Not Proven

The ability to safely perform a mass personnel airdrop while flying in close formation is a key Air Force capability needed to conduct a strategic brigade airdrop. However, operational testers found that C-17 aircraft wake air turbulence poses a danger to paratroopers jumping from aircraft flying in close formation. As a result, the Army has not yet approved mass airdrops of personnel from C-17s flying in close formation. Also, flight parameters, imposed to reduce the risk of paratrooper entanglements, increased pilot workload for conducting personnel airdrops and are not conducive to flying large numbers of aircraft in formation. In addition, the C-17 does not meet paratrooper exit rate requirements when airdropping personnel along with equipment bundles.

During operational testing, the Air Force found that the air turbulence created in the wake of C-17s, flying in close formation, can cause parachutes dropping from following aircraft to oscillate, partially deflate, or collapse. These conditions could result in serious injury or death to paratroopers if they occurred at altitudes too low to allow time for

recovery. Until this problem is resolved, the Army has not approved operational mass personnel airdrops from C-17s flying in close formation. Current Army safety restrictions require the Air Force to maintain a 5.5-minute or greater separation time between aircraft to avoid possible injury to paratroopers.

The current 5.5-minute aircraft separation restriction essentially prohibits formation flying, as it would take over 2.5 hours to conduct a strategic brigade airdrop. Army officials told us that they were in the process of formulating a time requirement of about 30 minutes for completing a strategic brigade airdrop. This is longer than it takes using the C-141, which was the standard initially desired by the Army. The C-141 can complete a strategic brigade airdrop in approximately 11 to 22 minutes, depending on visual conditions and formation spacing.

The Air Force, in June 1996, began a combination of follow-on development and operational testing to better understand the impact of C-17 wake turbulence on paratroopers and to identify operationally acceptable aircraft formations that would mitigate the wake turbulence problem. The follow-on C-17 testing includes conducting personnel formation airdrop tests during daylight hours using visual flight rules. Air Force officials estimate that this testing will be completed by February 1997. However, these officials told us that formation personnel airdrop testing under night or limited visibility conditions using instrument flight rules will not be conducted until late 1997. While there is no hard and fast rule, the Army generally tries to conduct airborne assaults under the cover of darkness or limited visibility to protect its forces and surprise the enemy.

Also, operational testing found that, because of turbulent airflows around the C-17, paratroopers jumping from both sides of the aircraft, tend to cross over behind the aircraft. This crossover increases the risk of paratroopers colliding and becoming entangled in their parachutes and could lead to serious or fatal injury if paratroopers are unable to quickly free themselves. To prevent this crossover problem, C-17 pilots are required to maintain strict flight parameters during personnel airdrop. These parameters include a high-deck angle (the nose of the aircraft is elevated 6 to 7 degrees as opposed to a normal elevation of 3 degrees or less) and precise airspeed. Operational testers found that maintaining these parameters created a high workload for C-17 pilots, who had difficulty maintaining the desired combination of these flight parameters at a constant altitude across the drop zone. DOD's C-17 Operational Test

and Evaluation Report (November 1995) indicated that these conditions are not ideal when flying large numbers of aircraft in formation.

In addition, operational testing revealed that the C-17 does not meet the Air Force and the Army requirement to airdrop equipment bundles and 102 paratroopers in a single pass over an average size drop zone. If this requirement cannot be met, the Army would have to either increase the length of the drop zone, require the aircraft to make a second pass over the drop zone, or reduce the number of paratroopers dropped on a single pass. None of these alternatives would be desirable to the Army because they would delay landing troops in the drop zone and require additional time to consolidate and reorganize troops once on the ground.

Multiyear Contract Cancellation Provisions

Although the Congress has approved and DOD has awarded a multiyear contract with an accelerated production schedule for the final 80 C-17s, that contract contains a clause that would permit the government, if full funding for a production lot under the multiyear contract were not available, to revert to single-year options without paying cancellation costs. While there would be an increase in program discontinuation costs to close out the contract at 100 rather than a 120, those additional costs have already been accounted for in our estimate of the potential savings. This clause was included at the direction of the Congress and would allow DOD to continue acquiring C-17s under the conditions negotiated prior to signing the multiyear contract.

Conclusion

An airlift fleet with 120 C-17s would cost over \$7 billion more in acquisition and operating and support costs than a fleet with 100 C-17s, while, in our opinion, providing only a marginal increase in strategic airlift capability and tactical utility. There are alternatives for delivering the small amount of strategic cargo not delivered by an airlift fleet with 100 C-17s in the MRS BURU. Employing one or a combination of these relatively low-cost alternatives could result in saving over \$7 billion in life-cycle costs for the additional 20 C-17s. These alternatives include a minor amount of prepositioning beyond the amount currently planned, using other airlift aircraft not considered available in the MRS BURU, extending the delivery time frame slightly, or adopting a combination of these alternatives.

DOD officials have expressed concern that additional prepositioning reduces the flexibility of the field commander to determine the force mix

that a major regional contingency will require. However, the additional reduction in flexibility would be about 2 percent if the entire shortage were prepositioned and less than 2 percent to the extent that training or set-aside aircraft were also used.

The 100 C-17s would also provide sufficient military capabilities to fulfill the missions modeled in the Tactical Utility Analysis with the exception of an extended range strategic brigade airdrop directly from the continental United States to a small, austere airfield. This capability, as set out in the Army's concept of operations, does not currently exist and until about fiscal year 2004 would have to be accomplished through the use of alternatives. Since this mission can be accomplished by moving some portion of the planned follow-on equipment to bases closer to the planned target or by making the C-5A replacement airdrop capable, we question the cost-effectiveness of spending billions for additional C-17s.

Matters for Congressional Consideration

Because of the potential savings of over \$7 billion and the relative contribution of the final 20 C-17s, the Congress may wish to consider funding only 100 C-17s and requiring DOD to reexamine the decision to acquire 120 C-17s. DOD can meet mission requirements by employing various relatively low-cost options and by extending the use of alternatives for accomplishing the longer range brigade airdrop. Further, before approving the acquisition of the final 20 C-17s primarily to support the brigade airdrop mission, the Congress should require that DOD certify that the aircraft's wake turbulence problems have been solved.

Agency Comments and Our Evaluation

In commenting on a draft of this report, DOD stated that the alternatives we suggested were operationally unacceptable. More specifically, DOD indicated that (1) CRAF aircraft cannot carry outsized or oversized equipment, (2) KC-10s may be needed for refueling, (3) training aircraft are needed to ensure a continuous pipeline of trained crews, (4) additional prepositioning would reduce flexibility, and (5) extension of the delivery time by 1 or 2 days would create unacceptable risks. (See app. II for DOD's complete comments.) However, careful review of DOD's comments indicates that its blanket rejection of any combination of these alternatives fails to recognize the following:

- Not all of the cargo to be delivered is outsized or oversized and additional contributions of CRAF aircraft could free up C-5s and C-17s for the outsize and oversize loads.

- Although the primary role of KC-10s is as refuelers, they could still make a contribution even if not dedicated to the airlift role, as they have in the past.
- The eight C-17s and six C-5s set aside for training could be used on a short-term basis in two nearly simultaneous major regional contingencies, just as training aircraft were used during Desert Storm.
- The reduction in flexibility from additional prepositioning is 2 percent or less of the planned force.
- While asserting increased risk, DOD has not rerun its war-fighting model with a delay of 1 or 2 days in the delivery time to determine whether there is, in fact, a significant increase in risk. Further, DOD has assumed that risk will increase without allowing for any compensating effects through the use of the alternatives we have suggested.

DOD agreed that 100 C-17s would be adequate to meet lesser regional contingency requirements. However, DOD indicated that an extended range brigade airdrop could not be accomplished with a fleet that included only 100 C-17s. DOD stated that prepositioning airdrop forces is not a realistic option because of time constraints, the need to obtain agreement from other nations for use of their territory, and the loss of the element of surprise.

We are not suggesting that prepositioning, that is permanent storage of equipment at forward bases, be used to support the brigade airdrop. We are suggesting that 15 or fewer loads of follow-on equipment could be moved to an appropriate base during the early part of the operation, close enough to the desired target to allow C-17s used in the initial airdrop to pick up that equipment and deliver it during the airland phase of the mission. We agree that use of third party bases would require obtaining permission for their use but believe that much of the groundwork for this type of agreement can be handled prior to the time when the bases would actually be needed. As regards to the element of surprise, we question whether the number of aircraft involved in an operation of this nature could be launched without attracting media attention during a crisis.

DOD recognized the existence of a C-17 wake vortex problem but recommended that we withdraw our suggestion that the Congress require certification that the problem has been solved before authorizing the final 20 aircraft. DOD maintained that the problem is not unique to the C-17 and a reporting requirement would be an inappropriate exaggeration of the issue. In our opinion, the ability of the aircraft to accomplish a key mission specifically called for in the justification for acquiring 120 C-17s (not just

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Less Expensive Options for Meeting
Requirements Could Save Billions

100) is critical and, therefore, certification that the wake vortex problem has been resolved is a reasonable requirement.

C-17 Program Cost Could Exceed \$43 Billion Despite Savings

The Air Force needs to achieve significant cost reductions to contain total program costs for the 120 C-17 program at the \$43 billion amount estimated by the Air Force in January 1994. Even after the reductions in production prices for the last 88 aircraft that the Air Force negotiated with McDonnell Douglas, total program costs decreased by only about \$174 million from the \$43 billion January 1994 Air Force estimate. Also, negotiated ceiling prices for aircraft in production lots XII through XV potentially could increase C-17 program costs by more than \$1 billion if individual production lots were to increase to their ceiling prices. Further, the contract provides for adjusting the prices for the last 72 aircraft to account for changes in costs that could not be accurately foreseen at the time the multiyear contract was negotiated.

Government and McDonnell Douglas Cost-Reduction Initiatives

Initiatives undertaken by both the government and McDonnell Douglas have significantly reduced prices for future C-17 aircraft. First, the Congress created a competitive environment for the C-17 contractor by directing DOD to establish the NDAA program to explore the use of nondevelopment aircraft as an alternative or supplement to the C-17.

Second, several Air Force initiatives contributed to lower C-17 production prices. The Air Force (1) performed a should cost analysis to serve as a basis for negotiating lower prices for the last 88 aircraft,¹ (2) provided the contractor an additional \$372 million to fund cost-reduction initiatives, (3) accelerated the production schedule, (4) negotiated fixed-price contracts with McDonnell Douglas for the next four production lots (VIII-XI) and not-to-exceed ceiling options for the balance of the 120-aircraft buy, and (5) obtained congressional approval to purchase the last 80 aircraft using multiyear procurement.

Also, as a result of the 1994 settlement,² McDonnell Douglas undertook its own analysis to identify ways of reducing C-17 production prices and, as

¹The should cost analysis was designed to promote improvements in the contractor's operations by challenging such things as existing workforce, methods, materials, and facilities and quantifying their impact on price estimates.

²In January 1994, DOD and McDonnell Douglas agreed to settle outstanding business and management issues concerning the C-17. Under the settlement, the contractor agreed to a number of management changes and improvements to ensure completion of the 120-aircraft program and reductions in the aircraft's cost. The government increased funding to cover additional testing and some management improvements and to settle all outstanding claims both filed and not filed as of January 6, 1994. The government also agreed to extend delivery schedules and revise various C-17 specifications. (See *Military Airlift: The C-17 Program Update and Proposed Settlement* (GAO/T-NSIAD-94-166, Apr. 19, 1994).)

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C-17 Program Cost Could Exceed \$43 Billion
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required by the settlement, will expend \$100 million of its own funds for additional projects to reduce C-17 production costs.

In the fall of 1994, as a part of their price reduction efforts, the C-17 program office and McDonnell Douglas jointly developed a computer model for estimating and reaching agreement on production costs for the last 88 aircraft, starting with production lot VIII. As part of this effort, in January 1995, the C-17 program office and McDonnell Douglas agreed to a production price baseline of \$24.2 billion (\$275 million average unit price) to use in the model. The contractor used the model to determine the impact that its cost-reduction initiatives would have on C-17 production labor hours, costs, and prices.

Table 4.1 summarizes the Air Force and contractor initiatives, which together reduced production prices for the last 88 aircraft by \$7.3 billion (from \$24.2 billion to \$16.9 billion). The \$16.9 billion (\$192 million average unit price) is the negotiated contract price for the annual production buys included in the lot VIII and beyond contract assuming an accelerated production schedule. The \$16.9 billion price excludes the cost of engines and other equipment furnished to McDonnell Douglas by the government. The multiyear contract, starting with production lot IX, reduced this price by another \$827 million to \$16.1 billion (\$183 million average unit price).

**Table 4.1: McDonnell Douglas C-17
Production Price for Last 88 Aircraft**

Then-year dollars in millions			
Description	Price for last 88 aircraft		
	Reduction	Total	Unit (average)
January 1995 baseline		\$24,196	\$275
Cost-reduction initiatives	\$5,100		
Accelerated delivery	1,356		
Transferred to other contracts	827		
Total	\$7,283	\$(7,283)	\$(83)
Lot VIII contract ^a		\$16,913	\$192
Multiyear reduction		(827)	(9)
Lot VIII with multiyear		\$16,086	\$183

Note: This is the production contract cost for McDonnell Douglas. It does not include costs for government-furnished equipment such as engines.

^aThe lot VIII contract value assumes an accelerated production schedule.

The Air Force performed the should cost analysis to identify the most probable production price for the remaining 88 aircraft. This analysis evaluated ongoing as well as new cost-reduction ideas for McDonnell Douglas and its suppliers. Following the should cost study, McDonnell Douglas undertook its own detailed analysis and identified other initiatives for reducing C-17 production costs. Program and contractor officials told us that McDonnell Douglas reached agreement with the Air Force on many of these initiatives and incorporated them into the joint C-17 production cost model. These initiatives lowered the negotiated target price for the remaining 88 aircraft by more than \$5.1 billion from the January 1995 production price baseline.

Many of these initiatives, however, required additional funding by both McDonnell Douglas and the Air Force. These additional costs are not reflected in the lot VIII and beyond contract prices. For example, McDonnell Douglas, as required by the 1994 settlement agreement, is spending \$100 million of its own funds to fund 40 of these cost-reduction initiatives. The Air Force also provided McDonnell Douglas \$372 million for additional cost-reduction projects. Included in this amount are (1) \$112 million in incentive payments for cost-reduction projects affecting production lots VIII and beyond that had been authorized by the initial development and production contract and implemented by the contractor prior to production lot VIII³ and (2) \$260 million, under the PE/PI contract to fund 37 new projects.

Table 4.2 summarizes by major cost categories how the cost-reduction initiatives reduced the production prices for the remaining 88 aircraft.

³Normally these incentive payments would have been paid to the contractor at the time each production lot under contract was awarded. However, the C-17 program office wanted to close out the initial C-17 development and production contract that authorized these projects and chose to buy out these payments rather than carrying the liability forward.

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Table 4.2: Impact of Cost-Reduction Initiatives on C-17 Production Prices for the Remaining 88 Aircraft

Then-year dollars in millions		
Cost category	Decrease	
	Amount	Percent ^a
Intercomponent work orders	\$1,805	35
Outside suppliers	976	19
Overhead	968	19
Direct labor	878	17
Other	473	9
Total	\$5,100	100

^aPercentages do not add due to rounding.

**Reduction in
Intercomponent Work
Order Costs**

The largest reduction (about 35 percent) comes from reducing the cost of intercomponent work orders. These work orders are for C-17 manufacturing done at other McDonnell Douglas divisions away from the main assembly facilities in Long Beach, California. At these other divisions, McDonnell Douglas is taking steps to reduce both direct and indirect costs by improving the manufacturing processes and efficiency at these facilities. It is also transferring work to either lower cost company facilities or to outside suppliers that can do it more efficiently.

For example, McDonnell Douglas plans to achieve more than \$1 billion in C-17 production costs reductions at its St. Louis, Missouri, facility by implementing a combination of cost-reduction initiatives to improve efficiency and by transferring a portion of the work done in St. Louis to the contractor's Macon, Georgia, facility.⁴ The Macon facility has lower labor costs and higher productivity and efficiency rates than other company facilities.

**Reductions in Supplier
Costs**

McDonnell Douglas also plans to achieve significant reductions in the prices charged by its suppliers. The prime contractor is (1) working with its suppliers to improve their manufacturing processes and/or redesigning components provided by these suppliers, (2) transferring work to more efficient suppliers, and (3) eliminating middleman costs by directly procuring major parts and components from source suppliers. For example, McDonnell Douglas plans to achieve over \$687 million in cost

⁴In C-17 Aircraft: Cost of Spare Parts Higher than Justified (GAO/NSIAD-96-48, Apr. 17, 1996), we reported that the Air Force paid significantly higher prices for spare parts manufactured at the McDonnell Douglas St. Louis Division.

reductions at its largest supplier, Vought Aircraft Division of Northrop Grumman Corporation. This amount includes an estimated \$300 million savings by improving the design and manufacturing of the C-17 engine enclosure.

**Reductions in Overhead
Costs**

McDonnell Douglas plans to decrease its overhead expenses by more than \$900 million. The contractor, for example, has initiated projects to reduce the cost of indirect staffing supporting the C-17 program by \$443 million and to reduce the cost of group health insurance and workman's compensation by \$266 million.

Specifically, the contractor plans to reduce the level of indirect staffing by 577 positions from 2,250 at the beginning of 1995 to 1,673 in 2001. For the entire corporation, McDonnell Douglas revised its employees' group health insurance program to incorporate a new point-of-service primary care program and to require supplemental premium contributions from employees whose working spouses elect not to accept their own employers' health insurance program as primary coverage. The contractor also projects significantly reduced costs due to a reduction in the State of California workman's compensation rates and improvements in the contractor's industrial accident safety record.

**Direct Labor and Other
Cost Reductions**

McDonnell Douglas expects to reduce its C-17 program direct labor costs by \$878 million through the implementation of several labor saving projects. For the most part, these projects are being implemented at the assembly facility in Long Beach to improve assembly labor and reduce idle time and the time required for rework and repair.

Other reductions to the production price include decreases related to profit/fee, warranty, facilities cost of money, and other nonlabor costs. For example, the estimated profit for the last 88 aircraft decreased by over \$275 million.

**Accelerating Procurement
Schedule Will Save Over a
Billion Dollars**

The Air Force and McDonnell Douglas reduced the contract price by \$1.4 billion by accelerating the baseline procurement schedule. Both the lot VIII and beyond and multiyear contracts contained an accelerated procurement schedule approved by the Under Secretary of Defense for Acquisition and Technology for use in planning and budgeting for C-17 production at the maximum affordable rate. The baseline procurement

profile used in the joint cost model provided for nine production lots (VIII-XVI) with a maximum procurement rate of 12 per year. The accelerated procurement profile provides for eight lots with a maximum procurement rate of 15 per year. A comparison of the two procurement schedules with their respective prices is shown in table 4.3. According to the contractor's proposal, the accelerated procurement rate buildup and higher quantities allowed the company to offer the reduced price.

Table 4.3: Comparison of Contract Procurement Baseline Profile With Accelerated Procurement Profile for Last 88 Aircraft
Then-year dollars in millions

Fiscal year	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total price
Baseline number	8	8	8	8	10	12	12	12	10	\$18,269
Accelerated number	8	8	9	13	15	15	15	5	0	16,913
Reduction										\$1,356

Transfer of Development and Support Costs

Contracts for C-17 development and prior production lots contained provisions for improving the aircraft and for field support. The Air Force and the contractor estimated the cost of this work in the January 1995 production price baseline to be about \$827 million. Starting with the production lot VIII and beyond contract, the Air Force transferred this work to the PE/PI and field support contracts. This was done to have the production contract reflect only the cost of producing the aircraft and to increase management's visibility and control over production costs.

Multiyear Procurement Will Reduce Contract Price

On the basis of a January 1996 proposal submitted by McDonnell Douglas, the Air Force sought and obtained congressional approval for multiyear procurement authority to purchase the last 80 C-17 aircraft over a 7-year period. In June 1996, the Air Force awarded McDonnell Douglas a \$14.2 billion 7-year multiyear contract for the last 80 C-17 aircraft starting with production lot IX in fiscal year 1997 and ending with production lot XV in fiscal year 2003.

The multiyear contract reduced McDonnell Douglas's target prices for the last 80 aircraft by \$827 million. On the basis of an accelerated procurement profile, the contract provides for a 5.5-percent discount from the negotiated prices in the annual lot VIII and beyond contract for production lots IX through XV. McDonnell Douglas's original proposal offered a 5-percent discount, but the contractor increased it to 5.5 percent due to a congressional desire for a larger discount. McDonnell Douglas did not

identify how it would achieve this additional reduction, and characterized it as a management challenge.

The multiyear contract also allows the Air Force to revert to the lot VIII annual buy contract options without renegotiating prices, if any year's buy under the multiyear contract is not fully funded. The lot VIII contract's variation in quantity clause allows the Air Force to choose either a baseline or an accelerated procurement schedule.

C-17 Program Costs Remain at \$43 Billion

In April 1994, we testified that the \$43 billion total program cost estimate to acquire 120 C-17s exceeded the last DOD estimate to acquire 210 aircraft.⁵ A 1996 Air Force estimate of total program costs for a 120 C-17s has decreased by only \$174 million since that time. Although both the 1994 and the 1996 estimates include multiyear procurement, the 1994 estimate is based on a maximum procurement rate of 12 aircraft per year while the procurement rate in the 1996 estimate is 15 aircraft per year.

Table 4.4 compares the 1994 and the 1996 estimates of total program costs. It shows that the Air Force reduced its budget estimate for C-17 production costs for the 120-aircraft program by over \$3 billion. This represents about a 10-percent decrease in production costs, or an average reduction of \$26.5 million per aircraft. For the most part, this decrease is a result of the Air Force negotiating lower prices with McDonnell Douglas for the remaining 88 aircraft.

Table 4.4: Total C-17 Program Costs for 120 Aircraft

Then-year dollars in millions			
Description	1996	1994	Change
Research and development	\$6,701.1	\$5,709.9	\$991.2
Production	29,234.8	32,414.8	(3,180.0)
Support	3,147.0	2,103.4	1,043.6
Modifications	1,278.7	0	1,278.7
Spares	2,197.2	2,523.3	(326.1)
Military construction	346.0	327.4	18.6
Total	\$42,904.8	\$43,078.8	\$(174.0)

The \$3.2-billion decrease in production costs was offset by increased estimates for research and development, aircraft modifications, and field support. According to program officials, the \$991-million increase in research and development funds is mainly for additional follow-on

⁵Military Airlift: C-17 Proposed Settlement and Program Update (GAO/T-NSIAD-94-172, Apr. 28, 1994).

development and operational testing, and the \$1.3-billion increase in modification funds is for the development and incorporation of modifications to the aircraft. Examples of planned funding for modification improvements include: \$247 million to improve the C-17 cargo compartment system, \$205 million to upgrade the aircraft's avionics, and \$150 million to enhance utilization of the cockpit.

According to the C-17 program office, the \$1-billion increase in support costs is due to (1) the extension from fiscal year 2001 to 2005 of McDonnell Douglas interim contractor support for fielded C-17 aircraft and (2) plans to fund many sustainment tasks under the weapon system procurement account that were previously funded under the operation and maintenance account.

Multiyear Contract Allows for Program Cost Growth

The contract prices for the last 50 aircraft could increase about \$1 billion because of ceiling prices contained in the multiyear production contract. On the basis of our analysis, the ceiling prices for contract options, starting with lot XII, exceed the negotiated target prices by about \$1 billion.

Further, the multiyear contract contains contract clauses that allocate the risk of unforeseen events between the government and the contractor. These clauses allow for increases or decreases in the price (for production lots X and XI) and the target cost and ceiling price for production lots XII through XV. For example, increases or decreases to materiel costs due to changes in inflation or currency exchange rates would result in adjustments to the price, target cost, target price, and ceiling price for a lot. These contract amounts could also be adjusted for cost increases or decreases to the prime contractor for changes in labor and overhead rates, loss of suppliers, new government compliance requirements, and extraordinary events such as earthquakes or fire if the net effect of these changes (upward or downward) is 2 percent or greater of the applicable fixed price or target cost amounts stated in the contract.

Agency Comments and Our Evaluation

In commenting on a draft of this report, DOD agreed that the estimated program cost remains at \$43 billion, but pointed out that the costs for additional research and development, testing, and modifications were not included in the earlier estimates because the items being covered by these costs were not known at that time. The need for the modifications was identified during testing. We agree that these costs were not reflected in

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the earlier estimates. However, major weapon systems generally require modifications as a result of testing. Not including any potential costs of these modifications ignores prior experience and understates potential costs.

DOD-Approved C-17 Program Cost and Schedule Aircraft Performance Criteria for Continuing the Program Beyond 40 Aircraft

DOD-established criteria	Objective	Threshold	Compliance
C-17 program milestone	Date		
Complete development testing	Dec. 94	June 95	Dec. 94
Start operational testing	Dec. 94	June 95	Dec. 94
Complete operational testing	June 95	Dec. 95	June 95
Initial operational capability (12 aircraft)	Jan. 95	July 95	Jan. 95
Reliability, maintainability, and availability evaluation	July 95	Jan. 96	Aug. 95
Full-rate production decision milestone IIIB	Nov. 95	May 96	Nov. 95
Program costs for first 40 aircraft	Estimate (fiscal year 1981 base-year millions)		
Research and development	\$4,089.1	\$4,702.5	\$4,070.1
Procurement	8,769.3	9,207.8	8,462.8
Military construction	138.0	158.7	133.0
Average unit procurement	219.233	252.118	211.6
Program aircraft performance	Performance parameter		
Payload at 3,200 nautical miles	130,000 lbs	110,000 lbs	131,000 lbs
Maximum payload landing field length	3,000 ft @ 160,000 lbs	3,000 ft @ 140,000 lbs	2,900 ft @ 160,000 lbs
Backup capability	2% grade	1.5% grade	3+ % grade
Turning capability (feet for 180-degree turn)	96 ft unpaved	90 ft paved	80 ft paved/ 96 ft unpaved
Rolling stock/outsize cargo	15 vehicles	15 vehicles	15 vehicles
Airdrop	102 personnel 110,000 lbs 40 CDS bundles	102 personnel 60,000 lbs 30 CDS bundles	102 personnel 110,000 lbs 30 CDS bundles
Aircraft reliability and maintainability	(Projected range)		
Mean time between maintenance, corrective (mean flight hours)	0.78	0.75	0.88 to 1.37
Mean time between removal (mean flight hours)	2.8	2.5	4.23 to 6.11
Mean man hours to repair	7.35	7.35	3.7 to 4.45

Comments From the Department of Defense

Note: GAO comments supplementing those in the report text appear at the end of this appendix.



ACQUISITION AND
TECHNOLOGY

OFFICE OF THE UNDER SECRETARY OF DEFENSE

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2 JAN 1997

Mr. Louis J. Rodrigues
Director, Defense Acquisitions Issues
National Security and International
Affairs Division
U. S. General Accounting Office
Washington, DC 20548

Dear Mr. Rodrigues:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report "MILITARY AIRLIFT: DoD Could Meet Mobility Needs With Fewer C-17s and Save Billions," dated November 20, 1996, (GAO Code 707109), OSD Case 1255.

The Department nonconcurs or partially concurs with all of the principal findings in this report and recommends the GAO withdraw the matters for congressional consideration.

The Department disagrees strongly with the GAO's assertion that a fleet with 100 C-17s and no Non-Developmental Airlift Aircraft could meet airlift requirements. The Joint Staff's Mobility Requirements Study, Bottom-Up Review Update specified, for a moderate level of risk, 120 C-17 equivalents as the minimum airlift required for two nearly simultaneous Major Regional Contingencies. Decreasing that amount results in increasing risk to a higher, unacceptable level. Less airlift translates to longer closure time, i.e., inability to deliver sufficient forces into theater during the critical halting phase at the beginning of a conflict. It exposes the first forces already in theater to undue risk and increases the chance of losing a battle or worse, the war.

While the Department agrees that reducing DoD's C-17 buy creates a savings, it is misleading to tout savings without specifying the time frame involved. The report uses the term life-cycle costs several times in explaining these savings, but it does not explain that the cost analysis used projects 34 years into the future. A casual reader will likely anticipate most of the savings can be taken in the near term. In reality, because the last 20 C-17s are to be fielded in 2004 - 2005, almost no savings would be seen in the Future Years Defense Plan. Moreover, only about half or less of GAO's advertised "savings" could be achieved during this time (2004 - 2005). The remainder would flow in as unspent operating costs over the following 25 years.

In addition, the three alternative measures that GAO suggests to make up for the airlift shortfall in a fleet of only 100 C-17s are operationally unacceptable for reasons specified in the attachment.



See comment 1.

See comment 2.

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Finally, the Department partially concurs with the GAO's assertion that the C-17 has a wake vortex issue and that "the C-17 has not yet demonstrated the capability to safely perform a mass airdrop of personnel while flying in close formation."

The Department's detailed comments to this report are in the enclosure. We appreciate the opportunity to comment.

Sincerely,



George R. Schneiter
Director
Strategic and Tactical Systems

Attachment

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GAO DRAFT REPORT - DATED NOVEMBER 20, 1996
(GAO Code 707109), OSD Case 1255

**"MILITARY AIRLIFT: DOD Could Meet Mobility Needs With Fewer C-17s
and Save Billions"**

DEPARTMENT OF DEFENSE COMMENTS

GAO'S PRINCIPAL FINDING: Strategic Airlift Requirements Can Be Met With 100 C-17s.

DoD RESPONSE: The Department does not concur. The Department disagrees with the GAO's assertion that a fleet with 100 C-17s and no NDAA [Non-Developmental Airlift Aircraft] could meet airlift requirements and save the government over \$7 billion in life cycle costs.

First, 120 C-17s are replacing 234 C-141s and are the minimum required to meet strategic airlift requirements with a moderate element of risk and to fulfill military-unique missions with a reasonable degree of flexibility. As outlined in the Joint Staff's Mobility Requirements Study, Bottom-Up Review Update (MRS BURU), the minimum airlift required for two nearly simultaneous Major Regional Contingencies (MRCs) is 120 C-17 equivalents. The Defense Acquisition Board which chose the 120 C-17 fleet option considered only airlift force mixes that met this requirement. This minimum amount of airlift involves a moderate level of risk in meeting requirements, so decreasing that amount results in an increased risk to a higher, unacceptable level. Less airlift translates to longer closure time, i.e., inability to deliver sufficient forces into theater during the critical halting phase at the beginning of a conflict. It exposes the first forces already in theater to undue risk and increases the chance of losing a battle or worse, the war. 100 C-17s alone fall more than 4000 tons short of meeting the DoD halting phase airlift requirement. This shortfall equates to elements of numerous fighting units arriving one to three days late. It should be noted the 120 C-17 requirement is conservative; more C-17s could be needed to move outsized cargo within the theater or to meet special operations requirements now supported by the C-141.

Moreover, the GAO does not address the effect of a 100 vice 120 C-17 fleet on the day-to-day operational tempo faced by the Air Mobility Command (AMC) commander. A look at the recent demands placed on the AMC strategic aircraft fleet in November illustrates how little slack there is in the airlift system available to conduct a limited contingency operation in addition to routine operations. In November alone, 56 scheduled priority-channel and special-assignment airlift missions were canceled for "no available aircraft." In addition, 20 exercise, joint training, and contingency support missions were not flown because the AMC fleet was overcommitted. That is an overcommitment before supporting any contingency the size of that analyzed in the MRS BURU. The Commander in Chief U.S. Transportation Command (CINCTrans) highlights this current high commitment rate and high operations tempo with an even more

See comment 1.

See comment 3.

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startling fact: "In the next two years, AMC will lose 47 PAA (primary aircraft authorized) C-141s and gain only 11 PAA C-17s." If only 100 C-17s would enter the AMC fleet, as the GAO recommends, AMC will have 119 fewer airlift aircraft than it has today. With the same ops tempo as in November, this translates to 70+ unsupported high priority missions, which is an unacceptable level of service to the warfighting CINCs. Reducing the buy to 100 from 120 will only worsen an already difficult situation.

Second, stating that a 100 C-17 option saves \$7 billion is misleading and should be clarified. The report uses the term life-cycle costs several times in explaining the supposed savings, but it does not explain that the cost analysis used covered 34 years. The average reader will likely anticipate most of the savings can be taken in the near term. In reality, because the last 20 C-17s are to be fielded in 2004 - 2005, almost no savings would be seen in the Future Years Defense Plan. Moreover, only about half or less of GAO's advertised "savings" could be achieved during this time (2004 - 2005). The remainder would flow in as unspent operating costs over the following 25 years.

Third, the three alternative measures that GAO suggests to make up for the airlift shortfall in a fleet of only 100 C-17s are operationally unacceptable:

1) Regarding the GAO's suggestion to increase the amount of prepositioned Army materiel, the Joint Staff's MRS BURU indicates this option is undesirable for two reasons. First, prepositioning decreases the warfighting CINC's flexibility to respond to a crisis since more of his equipment will be predetermined. Second, almost all the equipment that is suitable for prepositioning has been prepositioned. Therefore, the Joint Staff's thorough analysis of this option recommends no more prepositioning. Additionally, the costs of procuring the equipment and the prepositioning storage facility (either ashore or afloat) must be considered. Prepositioning also increases risk, because the locations chosen may not be where the equipment may be needed. Equipment prepositioned afloat increases risk over airlifted equipment, because it may not be possible to unload the equipment near where it is needed, thus delaying commitment to battle.

2) In reference to the GAO's suggestion to increase the use of Civil Reserve Air Fleet (CRAF), KC-10, and C-17 and C-5 training aircraft, none of these options is viable as a permanent solution. CRAF aircraft, while a solid partner with the military for airlift requirements, are not capable of carrying outsize cargo and have a very limited capacity to carry outsize cargo. It is the capability to carry outsize/oversize cargo and the flexibility to deliver it into small austere airfields that make the C-17 so useful in bringing needed combat equipment to the fight. The commercial freighters in the CRAF also require specialized ground-support equipment and are of limited use in constrained airfield environments. KC-10s are similar to commercial freighters and have the same constraints. Additionally, depending on the contingency, KC-10s may be heavily tasked in their primary role as air refuelers. The C-17 and C-5 training aircraft are necessary to maintain a pipeline of trained aircrews to operational flying units during a war so those units continue to maintain their wartime capability. Although these three sources (CRAF, KC-10s, or training aircraft) are available to fill a short-term critical need for airlift, they are unsuitable as a permanent solution to meet the airlift shortfall in a 100 C-17 fleet.

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See p. 38.

3) The GAO's suggestion to extend by a day or two the time in which the Army receives its equipment during the initial phase of a dual MRC scenario would result in an unacceptable delay of critical equipment to the war fighter. Elements of the following units would be delivered from one to several days late, after the end of the "halting phase" of the conflict: Six Patriot missile battalions, five combat aircraft squadrons, two aviation battalions, two Army special forces units, and a chemical decontamination unit. While this option has not been wargamed by the Joint Staff, history has shown combat forces arriving several days late are of little value in the battle.

GAO'S PRINCIPAL FINDING: 100 C-17s Would Suffice For Lesser Regional Contingencies and Strategic Brigade Airdrop.

DoD RESPONSE: The Department partially concurs. The Department does not concur with the GAO's assertion that a fleet of only 100 C-17s could meet Strategic Brigade Airdrop (SBA) requirements, though the Department agrees that 100 C-17s could meet Lesser Regional Contingency (LRC) requirements if no other crisis required airlift assets at the same time.

As the GAO states in the text of the report, 120 C-17s are needed to support the SBA extended-range mission, in accordance with the April 1996 Defense Planning Guidance. The GAO lists alternatives to reduce the number of C-17s required for SBA, including prepositioning airdrop forces using overseas staging bases and ignoring the requirement to project airdrop forces into an austere airfield environment.

See comment 5.

Prepositioning airdrop forces at intermediate staging bases as proposed by the GAO is not a realistic option, for there is insufficient time from alert to execution to preposition forces overseas. For example, when Iraqi forces invaded Kuwait, alert and execution orders were back-to-back to move U.S. forces into the theater as rapidly as possible. If the CINC had needed to conduct an SBA mission in response to the invasion, there would have been no time to preposition airdrop forces first. Therefore, timelines for the employment of an airborne force (airdrop begins 18 hours after notification) precludes the use of intermediate staging bases. Furthermore, the necessity for political clearance to use third party nations as staging bases for these operations would restrict the options available to the National Military Command Authority. Finally, prepositioning would also compromise operational security and eliminate any element of strategic or tactical surprise, an especially critical element in any large-scale airdrop operation.

See comment 6.

The requirement to project forces into an austere airfield environment is a realistic objective based on recent operational experience in Panama and Haiti and on real-world planning considerations. Being able to project airdrop into austere airfields dramatically increases the number of potential sites to insert U.S. forces. This in turn increases operational flexibility and increases the chance for mission success. By increasing the number of potential objective airfields, we greatly increase the difficulty for aggressor forces to defend them. This improves the opportunity for tactical surprise and eliminates the need to insert an even larger force to have to secure the larger airfields the GAO suggests using.

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GAO'S PRINCIPAL FINDING: Alternatives Can Be Used to Meet Strategic Brigade Airdrop Requirements With 100 C-17s.

DoD RESPONSE: The Department does not concur. The Department does not agree with the GAO's recommendation to use C-5As to augment 100 C-17s in the SBA role.

First, the Department has determined there is a need to augment a fleet of 120 C-17s with all 50 C-5Bs to accomplish the SBA mission. AMC would choose to use the C-5B over the C-5A because of the C-5B's better reliability and presence in the active duty inventory. The availability of the C-5A to offset the lost capability of 20 C-17s in the SBA mission is limited. The GAO states, "As of July 1996, there were 76 C-5As in the airlift fleet." Actually, there are 74 total aircraft inventory (TAI) C-5As in the inventory, but only 58 primary aircraft authorized (PAA) are available to the Air Force and funded for crews, supply, maintenance, and other logistics support. Of those 58, only 18 are active duty assets, and the rest are Reserve assets. Reserve forces are not trained, qualified or funded for brigade airdrop missions. Of the 18 on active duty, with a current mission capable rate of 58.8% for the C-5A, we could expect no more than eleven useful C-5As for a brigade airdrop mission. Therefore, only eleven C-5As would be available to replace 20 C-17s (or 16 referenced in the GAO report) with the caveat that they are limited to large airfields only. These eleven C-5As would not meet SBA requirements.

Second, the GAO's suggestion that DoD could wait to acquire an extended-range brigade airdrop capability until after 2007 when the C-5A is scheduled to be replaced is an unacceptable delay in mission capability. In addition, terminating the C-17 production at 100 and introducing an airdrop requirement onto the C-5A replacement would entail significant extra costs not accounted for by the GAO. Specifically, the C-5A replacement would involve one of three options, each with some associated cost: 1) acquiring more C-17s would have high nonrecurring and production costs from the interruption in the production line between the 100th aircraft and the first C-5A replacement; 2) a refurbishment of the C-5A system would have significant modification and test costs; and 3) a new aircraft acquisition would have large nonrecurring and procurement costs.

GAO'S PRINCIPAL FINDING: C-17 Airdrop Capability Not Proven.

DoD RESPONSE: The Department partially concurs. The C-17 has demonstrated important operational capabilities in the airdrop of heavy equipment, container delivery system bundles, and free-fall parachutists, to include a "slice," or partial demonstration of the strategic brigade airdrop mission. The Department does not have plans to demonstrate the full capability to perform the Army's strategic brigade airdrop mission on any airlift aircraft.

The Department recognizes there is a wake vortex issue with the C-17 and has been aggressively pursuing a solution. The Air Force and the Army are working jointly in Follow-On

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Test and Evaluation (FOT&E) to achieve an acceptable formation. Testing is ongoing with a potential operational capability release in February, using 20-foot static lines and 40,000 foot spacing between 3-ship C-17 elements.

GAO'S PRINCIPAL FINDING: Estimated Program Costs Remain at \$43 Billion and Could Increase.

DoD RESPONSE: The Department partially concurs. The GAO has overlooked a key point in its comparison of 1994 and 1996 total program costs, and it is unlikely the program cost could increase in the outyears.

The GAO's comparison of the 1994 and 1996 total program costs overlooks a key difference in these two sums: the 1996 program contains much lower production funding, but more funding for robust research and development and modification efforts. Although the GAO discusses this difference in terms of monetary amounts, it fails to discuss the implication. The 1994 program provides for a fleet of basic aircraft, whereas the 1996 program provides for the same fleet, plus funding to keep this fleet up to date as technology changes and the aircraft's performance is better understood. The reason the 1994 program did not contain this funding is that requirements for further development and modification were not known then. As with any aircraft, testing and operational experience were required to identify what modifications would be required. Initial Operational Test and Evaluation, completed in 1995, and subsequent operational experience have identified enhancements/deficiencies in the C-17, and the appropriate modifications are now programmed. Therefore, the 1996 total program cost contains substantially more effort than the 1994 cost. Additionally, this difference is more important today as technology changes at an increasing rate. To maintain the C-17 fleet as a modern airlift force over its 30+ year lifetime requires robust research and development and modification programs to take advantage of the appropriate technological advances and to remain compatible with international aviation standards.

The GAO's assertion that the C-17 program cost could increase because of ceiling prices on the last 50 aircraft (Lots XII through XV) is incorrect. These lots have firm ceilings, and future negotiations of initial targets to firm targets will not change the ceiling upon award of these option lots. With any Fixed Price type contract, it is in the contractor's best interest to come in at the lowest possible cost in order to maximize profit. Based on the C-17 contractor's recent performance and the incentive to maximize profit, it is unlikely the contractor will tolerate higher-than-expected costs. Therefore, the target costs negotiated, based on a thorough risk analysis, should remain accurate.

See pp. 47-48.

See comment 10.

MATTER FOR CONGRESSIONAL CONSIDERATION: The GAO suggested that, because of the potential savings of over \$7 billion and the relative contribution of the final 20 C-17s, the Congress may wish to consider funding only 100 C-17s and requiring DoD to reexamine the decision to acquire 120 C-17s. The GAO asserted that the DoD can meet mission requirements by employing various relatively low cost options and by extending the use of alternatives for accomplishing the extended range brigade airdrop.

DoD RESPONSE: The Department does not concur. As explained in previous comments, the Defense Acquisition Executive's decision to proceed with a fleet of 120 C-17s was the right decision providing the minimum acceptable airlift capability. This decision was based in part on the unanimous response of our warfighting CINCs for a 120 C-17 fleet versus any mix when they were asked to state their Commands' requirements to the Chairman, Joint Chiefs of Staff. Therefore, the options the GAO presents to meet the airlift shortfall are unacceptable.

MATTER FOR CONGRESSIONAL CONSIDERATION: The GAO suggested that, before approving the acquisition of the final 20 C-17 primarily to support the brigade airdrop mission, the Congress should require that DoD certify that the aircraft's wake turbulence problems have been solved.

DoD RESPONSE: The Department does not concur. The C-17 wake vortex issue does not warrant a congressional report. Wake vortices are not unique to the C-17, since all transport aircraft (including C-5s and C-141s) produce them, and their relative strength is proportional to the size and weight of the aircraft. The C-17's vortices are proportionally less than a C-5's and proportionally stronger than a C-141's. Therefore, since all aircraft produce vortices, the implication that the C-17 wake vortex issue is an unexpected problem unique to the C-17 is unfounded. These wake vortices present a constraint on the spacing of aircraft in formation, and the joint Air Force/Army test team are fine tuning the formation spacing within this constraint. Therefore, follow-on operational testing is required to determine the most suitable brigade airdrop geometry, not to correct an exclusive C-17 deficiency. To alert Congress and propose a certification on this matter would be an inappropriate exaggeration of the issue.

See comment 1.

See comment 9.

The following are GAO's comments on the Department of Defense's (DOD) letter dated January 2, 1997.

GAO Comments

1. Although the Mobility Requirements Study Bottom-Up Review Update (MRS BURU) recommended that a fleet with the capacity of 120 C-17s be acquired, the basis for that recommendation was a set of assumptions concerning the (1) war fight, (2) expected levels of prepositioning, and (3) timing of the scenarios. Our review indicated that there are individual measures that DOD should implement to change the basis for those assumptions. DOD asserted that less than 120 C-17 equivalents would increase risk to an unacceptable level, without considering the MRS BURU scenario in terms of any of our suggested measures to offset a reduction in airlift. DOD's assertion that there would be an increase in risk beyond the moderate range is not established by evidence or analysis.
2. To ensure that no misunderstanding occurs, we have modified the report to identify the portion of the \$7 billion expected savings that would come from reductions in acquisition and the portion that would be foregone operating costs over the life of the aircraft.
3. We agree that replacing 234 C-141s with 100 or 120 C-17s will result in fewer aircraft in the fleet. However, DOD decided in April 1990 that a significant reduction in the number of aircraft was acceptable when it reduced the planned C-17 buy from 210 to 120. The reduction was based on the increased capability of the C-17 and the change in the threat. The Defense Acquisition Board's decision was based on the findings of the MRS BURU, the Strategic Airlift Force Mix Analysis, and the Tactical Utility Analysis, which considered wartime requirements, not the Air Mobility Command's peacetime operating tempo.
4. DOD claims that additional prepositioning in support of two major regional contingencies is unacceptable because it would reduce flexibility. However, the MRS BURU found that the materiel shortfall could be delivered to the theater on prepositioning ships. The decision on how much to preposition afloat was based on the decision that the airlift fleet would include 120 C-17 equivalents. More prepositioning would diminish by 2 percent the theater commanders's flexibility to alter the airlift flow. However, the Joint Staff could not provide any analysis to support why a 2 percent or less decrease would be unacceptable. Further, our analysis has accounted for the costs involved in prepositioning either on land or on ships. Also, the increased risk is, in our opinion, minimal. The equipment is

a very small portion of the amount of equipment involved in any contingency operation, it would be located in areas that are the most likely sites of potential trouble, and it would not be substantially further from potential use sites than if it were retained in the United States.

5. DOD states that the use of staging bases during a brigade airdrop is not a realistic option because of the time involved. However, we are not suggesting that troops or equipment be prepositioned at an overseas base for a potential strategic brigade airdrop. We are suggesting that some of the equipment delivered as part of the airland follow-on phase of the brigade airdrop—less than 15 C-17 loads—be moved first to staging bases as part of the initial deployment so that it can be picked up by C-17s used in the initial airdrop. This would eliminate the time needed by these C-17s to return to the United States to pick up this equipment.

6. Although DOD considers this a realistic objective, DOD cannot currently accomplish this directly from the United States to a small, austere airfield as desired by the Army. Our point is not that this capability never be acquired but that a delay in acquiring it will result in significant savings.

7. We have modified the report to reflect that there are 74 C-5As in the airlift fleet of which 16 are undergoing depot maintenance or used for training purposes.

8. The costs DOD refers to will occur as a result of replacing the C-5A whether or not any other actions are taken.

9. DOD's response states that the strategic brigade airdrop operational capability release is targeted for February 1997, using 20-foot static lines and 40,000 foot spacing between 3-ship C-17 elements. However, DOD's response fails to address two important points. First, the Army does not have an operational 20-foot static line. It needs to be developed, tested, and certified. Second, standard spacing for formation personnel airdrop using C-141s is 6,000 to 12,000 feet between elements. The larger separation of the C-17, in addition to the formation being wider than with other aircraft, would result in a longer time to complete the airdrop, and a greater dispersion of troops over a larger drop zone. This would delay getting troops on the ground and require additional time to consolidate and reorganize those troops into an effective fighting force, thereby increasing the risk to the operation.

10. We agree that it is in the contractor's interest to maximize profit. However, clauses included in the multiyear contract allocate risk between the government and the contractor that arises from events over which they may have little or no control. If these events occur, then the cost of the contract to the government can increase.

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